



# INRMP CLIMATE CHANGE ADAPTATION WORKSHOP

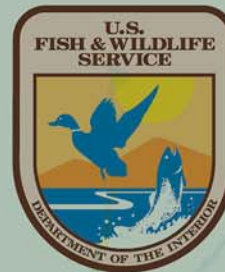
detachment fallbrook

28 & 29 august 2013

Facilitating Climate Change Adaptation in  
Naval Weapons Station Seal Beach  
Detachment Fallbrook's INRMP  
Fallbrook, California



WORKSHOP SUMMARY



Workshop Organizers: Carolyn Enquist (NPN), Dawn Lawson (SPAWAR), Robert Wolf (Tierra Data), Christy Wolf (Detachment Fallbrook), and Liz Kellogg (Tierra Data)

## Table of Contents

|  |    |
|--|----|
| Executive Summary.....   | 1  |
| Notes from Plenary Presentation (Morning of Day 1).....        | 4  |
| Breakout Groups (Afternoon of Day 1 and Morning of Day 2)..... | 6  |
| Coastal Sage Scrub Group 1 Synopsis .....                      | 7  |
| Riparian Woodland Group 2 Synopsis .....                       | 8  |
| Synthesis and Group Discussion .....                           | 10 |
| Adaptation Planning .....                                      | 12 |
| Strategic Climate-Informed Monitoring .....                    | 12 |
| Group Discussion about Adaptive Management .....               | 14 |
| Closing Comments .....   | 22 |
| Workshop Evaluation.....                                       | 23 |
| References .....   | 29 |

## Appendices

|             |  |
|-------------|--|
| Appendix A. | Workshop Agenda  |
| Appendix B. | List of Materials in Participant Binders   |
| Appendix C. | Group 1 Products – Coastal Sage Scrub; Ecosystem Conceptual Model, Hypotheses of Change Table, and Strategic Actions Table |
| Appendix D. | Group 2 Products – Riparian Woodland; Ecosystem Conceptual Model, Hypotheses of Change Table, and Strategic Actions Table  |
| Appendix E. | Powerpoint Presentations   |

## List of Tables

|          |                                    |   |
|----------|------------------------------------|---|
| Table 1. | List of Workshop Participants..... | 2 |
|----------|------------------------------------|---|

## List of Figures

|           |  |    |
|-----------|--|----|
| Figure 1. | Adaptation planning framework to be used in the workshop.....  | 6  |
| Figure 2. | Potential actions for initial climate scenario for CSS and Riparian Habitats on Detachment Fallbrook. .... | 11 |

**Facilitating Climate Change Adaptation in  
Naval Weapons Station Seal Beach Detachment Fallbrook's INRMP,  
San Diego County, California**

**List of Acronyms**

|       |   |
|-------|---|
| ARTO  | arroyo toad                                   |
| BO    | Biological Opinion                            |
| CAGN  | California gnatcatcher                        |
| CCS   | coastal sage scrub                            |
| DoD   | U.S. Department of Defense                    |
| EBV   | essential biodiversity variable               |
| GHG   | greenhouse gas                                |
| INRMP | Integrated Natural Resource Management Plan   |
| IPCC  | Intergovernmental Panel for Climate Control   |
| LTETM | Long-Term Ecological Trend Monitoring Program |
| LVBI  | least Bell's vireo                            |
| SCIM  | Strategic Climate-Informed Monitoring         |
| SKR   | Stephen's kangaroo rat                        |
| USFWS | U.S. Fish and Wildlife Service                |
| USGS  | U.S. Geological Survey                        |

## Workshop August 28 and 29, 2013

08:00–16:00

### Workshop Summary

#### Executive Summary

Detachment Fallbrook convened a 2-day workshop entitled “Facilitating Climate Change Adaptation in Naval Weapons Station Seal Beach Detachment Fallbrook's INRMP,” on August 28 and 29, 2013. The goals of the workshop were to use an adaptation planning framework to (1) develop specific management and monitoring strategies to support adaptation planning on Detachment Fallbrook; (2) serve as a case study to develop and test methods in a simplified operational environment to support the development of a strategic plan to incorporate climate change adaptation planning into Camp Pendleton's INRMP; and (3) develop a process to facilitate integration of climate change adaptation more generally into Integrated Natural Resource Management Plans (INRMPs) within the context of the military mission and existing threats and management. Twenty-two representatives participated, including staff from Detachment Fallbrook, Camp Pendleton, SPAWAR, Pacific Fleet, NAVFAC LANT, state and federal regulatory agencies, academic institutions, non-governmental organizations, and private consulting organizations (Table 1). The workshop was modeled after workshops put on by the Southwest Climate Change Initiative in 2009

([http://nmconservation.org/projects/new\\_mexico\\_climate\\_change/](http://nmconservation.org/projects/new_mexico_climate_change/)) and was organized by Carolyn Enquist (The National Phenology Network), Dawn Lawson (U.S. Navy – SPAWAR SSC Pacific), Rob Wolf (Tierra Data Inc.), Christy Wolf (Naval Station Seal Beach, Detachment Fallbrook) and Elizabeth Kellogg (Tierra Data Inc.). (The agenda is found in Appendix A, and Appendix B lists the materials in the workshop participant binders.) The objectives of the workshop were to:

1. Provide information about the observed and projected effects of climate change in the Southern California region.
2. Introduce a framework for installation-level climate change adaptation planning within the context of existing management (i.e., the INRMP).
3. Develop hypotheses for effects of climate change under two climate change scenarios on:
  - a. Coastal sage scrub and riparian habitats in western San Diego County; and
  - b. Existing management strategies for these habitats.
4. Identify strategic actions to reduce the potential adverse effects of climate change on species and ecosystems.
5. Identify strategic climate-informed monitoring approaches.
  - a. Review ongoing biological monitoring efforts to determine utility in evaluating hypotheses of change.
6. Identify, if time permitted, opportunities for regional versus installation-level strategic action and how work at both levels can support and reinforce each other.

Facilitating Climate Change Adaptation in  
Naval Weapons Station Seal Beach Detachment Fallbrook's INRMP,  
San Diego County, California

Table 1. List of Workshop Participants

| Name  | Institution                    | Email                         | Group     |
|---|--------------------------------|-------------------------------|-----------|
| Cara Allen  | State of California FWS        | Cara.Allen@wildlife.ca.gov    | CSS       |
| Peter Beck  | USFWS                          | Peter_beck@fws.gov            | Riparian  |
| Bill Berry  | MCB Camp Pendleton             | william.h.berry@usmc.mil      | CSS       |
| Chuck Black (Day 2 only)  | MCAS Miramar                   | charles.h.black@usmc.mil      | CSS       |
| David Boyer (Day 1 only)  | MCAS Miramar                   | david.a.boyer1@usmc.mil       | CSS       |
| Daniel Cayan (1 <sup>st</sup> half of Day 1 only)                               | Scripps Institute/USGS         | dcayan@ucsd.edu               | N/A       |
| Elsa Cleland (Day 1 only)   | UCSD                           | ecleland@ucsd.edu             | CSS       |
| Carolyn Enquist   | The National Phenology Network | cenquist@email.arizona.edu    | N/A       |
| Kylie Fischer   | ICF International              | kylie.fischer@icfi.com        | Riparian  |
| Charles Hamilton (1 <sup>st</sup> half of Day 1, 2 <sup>nd</sup> half of Day 2) | MCB Camp Pendleton             | charles.hamilton@usmc.mil     | Riparian  |
| David James   | NAVFAC LANT                    | david.m.james@navy.mil        | Riparian  |
| Anna Kellogg  | Tierra Data Inc.               | annak@tierradata.com          | Riparian* |
| Liz Kellogg   | Tierra Data Inc.               | liz@tierradata.com            | Riparian  |
| Dawn Lawson   | SPAWAR SSC Pacific             | dawn.lawson@navy.mil          | CSS       |
| James Lockman   | Tierra Data Inc.               | jameslockman@tierradata.com   | Riparian  |
| Ryan Lockwood   | Detachment Fallbrook           | ryan.s.lockwood1.ctr@navy.mil | CSS       |
| Jacque Rice (Day 1 only)  | Pacific Fleet                  | jacqueline.rice@navy.mil      | Riparian  |
| Trish Smith   | The Nature Conservancy         | trish_smith@tnc.org           | CSS       |
| Brenna Vredevelde   | Tierra Data Inc.               | brenna@tierradata.com         | CSS*      |
| Diane Walsh   | MCAS Pendleton                 | diane.walsh@usmc.mil          | Riparian  |
| Bill Wild   | SPAWAR SSC Pacific             | bill.wild@navy.mil            | Riparian* |
| Christy Wolf  | Detachment Fallbrook           | christy.wolf@navy.mil         | Riparian  |
| Robert Wolf   | Tierra Data Inc.               | rob@tierradata.com            | CSS*      |

\*Group facilitators.

The views or opinions expressed by workshop participants were meant for discussion purposes only and do not necessarily reflect any particular agency policy or official position of the U.S. Government.

Key outcomes of the workshop were:

- Agreement on conceptual ecological models for coastal sage scrub and riparian ecosystems.
- Identification of practical adaptation strategies that could be implemented by managers to build ecosystem resilience and support the military mission.
- Identification of information gaps.
- Development of a shared vision for a strategic climate-informed monitoring approach.

Workshop participants were divided into groups. One group worked on coastal sage scrub and the other on riparian communities. Each group was given a description of their ecosystem and management objectives relevant to Detachment Fallbrook and a draft conceptual model for each system. Each group then completed the conceptual model for the system (Appendices C and D). Each group then developed hypotheses of change (climate change effects [Tables C-1 and D-1 in appendices C and D, respectively]), and identified monitoring actions to evaluate the hypotheses and strategic actions if the effects manifested as hypothesized (Tables C-2 and D-2 in Appendices C and D, respectively). Each group then selected the most important strategic actions for the two conservation features and discussed opportunities for implementation, as summarized below.

#### Group 1 – Coastal Sage Scrub

- Suppress populations of high-priority exotic plant species via targeted herbicide applications – control or eradication.
- Identify and protect important habitat for populations of California gnatcatcher (CAGN) and Stephen's kangaroo rat (SKR) as refugia from fire. Work with fire department to develop pre-suppression as well as suppression actions tailored to these refugia.
- Use targeted grazing to reduce the biomass of annual exotics (i.e., decreasing thatch to reduce wildfire threat and providing more suitable habitat for SKR.)

#### Group 2 – Riparian Woodland

- Conduct fluvial assessment to identify mitigation opportunities.
- Assess stream community structure and geomorphology.
- Tie mitigation to opportunities to enhance infrastructural integrity.

At the end of the workshop, the participants synthesized information developed by the individual groups and discussed monitoring approaches.

Based on the post-workshop evaluation completed by the participants, the workshop and exercises were very useful.

## Notes from Plenary Presentation (Morning of Day 1)

The participants convened at 8 a.m. Each participant was given a binder with all the materials for the workshop (Appendix A is the meeting agenda, and Appendix B lists the contents of the workshop binder). Christy Wolf welcomed the group to the Detachment, and then the participants identified themselves and spoke about what brought them to the workshop.

This was followed by a series of Powerpoint presentations<sup>1</sup> that lasted until lunch.

Dawn Lawson gave a presentation that provided a context for the workshop. Her presentation recognized the many organizations contributing to the workshop, the U.S. Department of Defense (DoD) guidance for conducting the workshop, the workshop's purpose and rationale for its structure, and the rationale for studying Detachment Fallbrook. DoD Instruction 4715.03 states that

*All DoD Components shall, in a regionally consistent manner, and to the extent practicable and using the best science available, utilize existing tools to assess the potential impacts of climate change to natural resources on DoD installations....*

The workshop was convened as part of an effort to develop a process to incorporate climate change adaptation planning into Integrated Natural Resource Management Plans (INRMPs), using Detachment Fallbrook as a case study. The workshop was modeled after workshops put on by the Southwest Climate Change Initiative in 2009 ([http://nmconservation.org/projects/new\\_mexico\\_climate\\_change/](http://nmconservation.org/projects/new_mexico_climate_change/)). Detachment Fallbrook was chosen because it has (1) a well developed natural resources program; (2) high biodiversity requiring balancing trade-offs among conservation targets; (3) multiple threats from global change; and (4) a simplified military operational environment.

Christy Wolf gave an introduction to the Detachment. The mission of Detachment is to:

*Support Pacific Fleet's combat readiness and sustainability, as a detachment of NAVWPNSTA Seal Beach, providing major ordnance storage, maintenance, production, and distribution facilities for the western United States.*

Christy Wolf described the mission drivers of the installation that give shape to her natural resource program. These include safety and security; infrastructure; fire protection; installation restoration sites; pre-military land use; and lack of active training, public access, and recreation. She then introduced the key aspects of her natural resources program, including listed species management (for CAGN, arroyo toad, SKR, least Bell's vireo, and southwestern willow flycatcher), fire management, grazing, exotics control, education, monitoring of non-threatened and endangered (T&E) species, and implementation challenges. The challenges included staffing limitations, subject matter expertise, funding, compliance-focused regulation, and day-to-day issues.

---

<sup>1</sup> Please see Appendix E for copies of all Powerpoint presentations

Liz Kellogg, who has authored over 25 INRMPs, briefly discussed her experience in incorporating climate change into natural resource programs for installations. She described the many impediments managers encounter when incorporating ideas related to climate change into INRMPs and their programs. These included education on the subject, limitations on staffing, an unwillingness by overtaxed staff to take on more work when the subject is complex and uncertain, and the lack of hard regulatory requirements related to climate change activities. Although not presented to the group because of technical problems, her Powerpoint presentation regarding the nature of INRMPs is included in Appendix E.

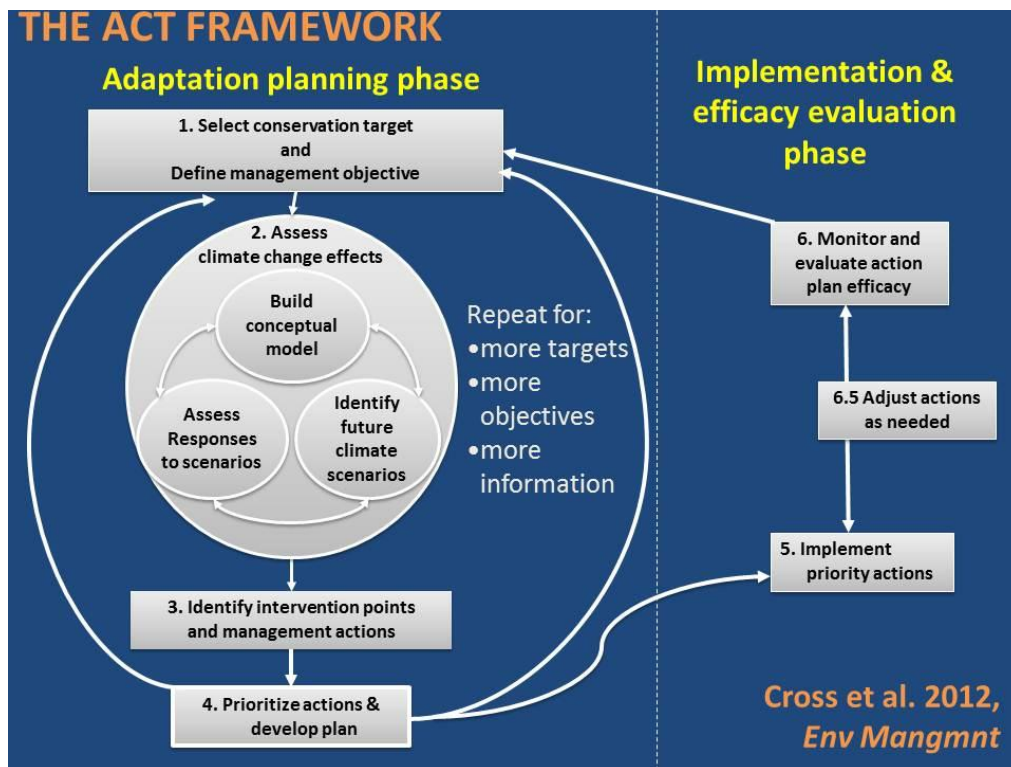
Dan Cayan then gave a state-of-the-art synopsis on climate change research focused on the Southern California region. Key points discussed were:

- Southern California has one of the greatest year-to-year variability in precipitation of any locale in the country.
- Southern California may likely experience the most pronounced drying trends predicted for the country by late in the century (using the BCSD model).
- The high variability of weather and short-term climate will continue.
- Afternoon summer temperatures are predicted to increase significantly at mid-century (2035–2064).
- Greenhouse gas (GHG) scenarios tend to track relatively closely until mid-century, when they begin to branch away from each other significantly.
- Recent Intergovernmental Panel for Climate Control (IPCC) climate model projects for California precipitation are scattered, but several show significant drying.
- Heat waves are predicted to become more severe.
- These factors will likely make wildfires more of a concern.
- Sea level rise will likely occur at an increasing rate.

After a quick break, Elsa Cleland talked about the ecological effects of climate change in Southern California. Her presentation focused on the following issues:

- Species distribution models provide an important starting point for predicting species at risk for declines with climate change
- Strategies for restoration and adaptation to climate change need to consider other interacting environmental factors, such as shifting habitat, species interactions, invasive species, nitrogen deposition, and fire regimes.
- Opportunities for creative and effective conservation of sensitive species and habitats can be found through understanding of phenology and timing of resource availability.

Carolyn Enquist then gave an overview of the adaptation planning framework to be used in the workshop. This process follows the approach in Cross et al. (2012), as shown in Figure 1.



**Figure 1. Adaptation planning framework to be used in the workshop.**

Robert Wolf then gave a brief overview of how the mechanics of the workshop would transpire over the next day and a half. He described the agenda for the two groups, including their tasks, and their products at the end of the 2 days. These included reviewing and selecting a management objective, building a conceptual model, and completing Tables C-1 and D-1 (hypotheses of change) and Tables C-2 and D-2 (strategic actions) in Appendices C and D, respectively. He also oriented the group to the format and contents of the workshop binder (Appendix B).

## **Breakout Groups (Afternoon of Day 1 and Morning of Day 2)**

The organizers of the workshop assigned each participant to one of two groups based on expertise prior to the workshop. Participants were invited to change groups if they had a greater interest in the group to which they were not assigned. Table 1 identifies the participants in each group. Two facilitators for each group were assigned to help take notes and keep track of time during the breakout group sessions. A noted, each participant was provided a binder of materials for the group session.

Each group started by reviewing the status of their assigned conservation target (coastal sage scrub [CSS] or riparian woodland) at Detachment Fallbrook and then choosing an objective to work with from among the current management objectives in the INRMP for that target. They then worked to develop conceptual models that detailed the way ecosystem drivers could affect conservation targets, with the aim of identifying points of intervention and proposing strategic actions to benefit conservation goals

within the military mission. The conceptual models used the following framework for parsing the key elements of the ecosystem:

*Driver* – These are large-scale processes that are responsible for creating the character of an ecosystem, and the ultimate factors that enable or contribute to proximate pressures that affect the conservation target. Drivers are synonymous with underlying factors or root causes. These include such factors as wildfire, temperature, precipitation, N-deposition, and invasion by exotics.

*Pressures* – These are the forces (positive or negative) that a given driver can affect upon the conservation target. Pressures can affect other pressures as well. Examples of pressures include habitat fragmentation, drought stress, competition from exotics, large storms, altered river flows, and increased fire frequency.

*Effect on Conservation Target* – This is the response that the conservation target experiences from a given pressure—the biophysical or population-level impacts of a pressure on the conservation target. Effects can influence other effects as well and include tree mortality, increased recruitment, decreased vigor, and reductions in seed bank.

*Conservation Target* – This is the species, species group, or community that is the focus of the exercise.

*Strategic Action* – This is a management, policy, or monitoring invention that is designed to mitigate the influence of, or track the magnitude of a given Driver or Pressure. These interventions are undertaken to reach the project's objectives and ultimate conservation goals. Actions can be applied to Drivers, Pressures, or directly to the Conservation Targets. These are synonymous with strategies, interventions, activities, responses.

The two groups worked to complete Tables C-1 and D-1 (in Appendices C and D, respectively) followed by Tables C-2 and D-2 (in Appendices C and D, respectively) on the following day. These tables were intended to further refine the group's understanding and agreement on both the hypotheses of ecological change that climate change could present (Table 1), and the strategic actions proposed for Fallbrook's adaptation plan (Table 2). Both tables challenged the groups to think about how their hypotheses of change and strategic actions could be altered when considering two plausible climate change scenarios: the more moderate one offered by the Department of Energy's (DOE) Parallel Climate Model (PCM) model 2035–2064 and the more extreme Oceanic and Atmospheric Administration (NOAA) Geophysical Fluid Dynamics Laboratory CM2.1 model (GFDL) model 2035–2064 (Cayan et al. 2008).

## Coastal Sage Scrub Group 1 Synopsis

The following management objectives were originally presented to Group 1:

1. *Maintain viable populations of California gnatcatcher, in concert with a healthy and biodiverse coastal sage scrub community, and consistent with military mission requirements.*
2. *Maintain a balance between early seral stage CSS (grass and forb dominated) suitable for Stephens' kangaroo rat and later seral stages suitable for the California gnatcatcher.*
3. *Maintain a minimum of 2,000 acres of CSS suitable for gnatcatchers (USFWS 2003).*

After deliberations, the group slightly altered and combined the first two objectives to form a single objective:

*Maintain a healthy and heterogeneous CSS community that contains a balance between early seral stage CSS (grass and forb dominated) suitable for Stephen's kangaroo rat and later seral stages suitable for the California gnatcatcher.*

The group felt that combining the objectives for the CAGN and SKR into a single objective focused the group's attention on the need to balance the maintenance of these two habitat types.

For the conceptual model and Tables C-1 and C-2 for the CCS Group, see Appendix C.

During the synopsis at the beginning of the afternoon session on Day 2, the CSS Group presented their top three strategic actions to the workshop participants:

- Suppress populations of high priority exotic plant species via targeted herbicide applications – control or eradication.
- Identify and protect habitat for important populations of CAGN and SKR as refugia from fire. Work with fire department to develop pre-suppression as well as suppression actions tailored to these refugia.
- Use targeted grazing to reduce the biomass of annual exotics (i.e., decreasing thatch to reduce wildfire threat and providing more suitable habitat for SKR).

The primary climate change drivers were increased temperature, prolonged drought, and increased wildfire events. Using these drivers to hypothesize effects on conservation targets revealed how the balance between CAGN and SKR priorities and conservation actions might shift. For example, the group hypothesized increases in adult shrub mortality in the CSS with prolonged drought and potential fire. Thus, the current situation—where population dynamics in CSS result in ample high-quality habitat for CAGN such that shrub restoration is rarely needed but biomass reductions are required to maintain SKR habitat—might shift. If such a shift occurred, maintenance of later stage CSS suitable for CAGN through shrub species restoration might be required and maintenance of SKR habitat through biomass reduction might be reduced.

The group discussed CSS in the context of three community types: an early stage (grass and forb dominated) and two later stages (drought deciduous and evergreen communities). The group also discussed the potential for novel species compositions that do not exist now, but that may provide suitable habitat for CAGN in the future (as seen now in some areas in Baja California).

## **Riparian Woodland Group 2 Synopsis**

The following management objectives were originally presented to Group 2:

1. *Provide habitat for sensitive species by managing threats from invasives, grazing, fire (including wildland fire and suppression and presuppression activities), sedimentation, and erosion.*
2. *Maintain viable populations of least Bell's vireo in accordance with terms and conditions of the Fire Management Plan BO (USFWS 2003), in concert with other sensitive species and a healthy and biodiverse*

*riparian community that includes self-perpetuating reproduction of native woody species and large, mature trees.*

The group opted to modify the above objectives as follows:

*Maintain suitable habitat and conditions for least Bell's vireo in accordance with terms and conditions of the Fire Management Plan BO (USFWS 2003), in concert with other sensitive species and a healthy and biodiverse riparian community that includes self-perpetuating reproduction of native woody species and large, mature trees.*

This objective, through focusing on the Fire Management Plan BO (USFWS 2003), kept the focus of the group on the interior drainages of the installation and not on the Santa Margarita River. Because the Santa Margarita drainage has arroyo toads among some other idiosyncratic issues, it was not addressed in the objective.

For the conceptual model and Tables D-1 and D-2 for the Riparian Woodland Group, see Appendix D.

Following the CSS Group, the Riparian Woodland Group presented their top three strategic actions to the workshop participants:

- Conduct a fluvial assessment to identify mitigation opportunities.

A common theme discussed was the maintenance of water availability as a tool to mitigate the negative effects of prolonged drought, decreased ground water availability, and fire. The group decided that restoring proper groundwater recharge and percolation would help to improve the system's resistance to climate change threats. The idea would be to prioritize "hot spots" that are not functioning at optimal levels, and restore sections of the drainages over the course of 15–20 years to improve hydrologic functioning.

- Assess stream community structure and geomorphology.

Wildland fire was tagged as a serious threat to riparian habitats. There was a tradeoff identified between protecting the riparian environment versus providing habitat for listed species. Grazing was identified as a very efficient way of limiting fuel loads in surrounding habitats, but it can negatively affect riparian areas. A solution was developed to fence the riparian areas while simultaneously providing for supplemental water troughs and shade areas.

- Tie mitigation to opportunities to enhance infrastructural integrity.

Require future improvements and repair of infrastructure to enhance riparian habitat in terms of structure, function, or both.

Bill Berry brought up the issue of whether these recommendations are specific to climate change. In a sense, how are we addressing climate change impacts, if these are already actions we should take?

Dawn Lawson and Christy Wolf replied that the strategic actions might change in priority or they might give a new context for ongoing actions. Bill stressed that (1) it will be necessary to show the direct link between proposed actions and climate change-related work we may want to do in the future; and the strategic action is not simply a pet project that a manager wants to continue but with more funding. Carolyn Enquist stated that timing, frequency, and priorities might change based on the consideration of climate change impacts.

James Lockman said that much of the Riparian Woodland Group's discussion focused on the current channelization of Fallbrook Creek. Given the climate change drivers of more extreme heat events and overall decreases in precipitation with increases in large rain events, restoration to a more natural geomorphology would benefit general ecosystem integrity by enhancing percolation, sediment trapping, recharging the water table, water storage, and water quality. He mentioned Fallbrook Public Utilities proposal to use Fallbrook Creek for recycled water treatment, which also would benefit the installation's natural resources.

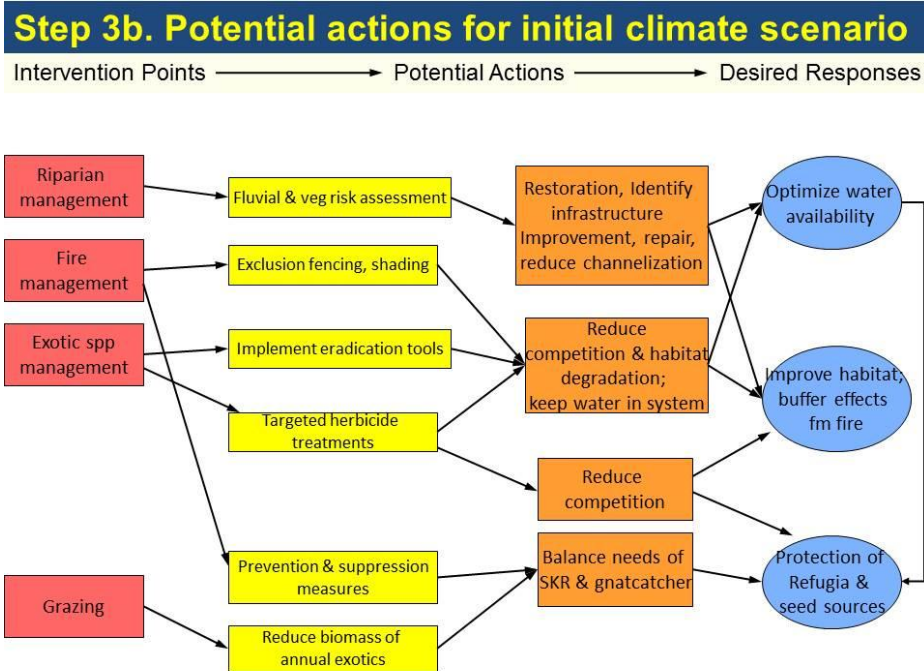
As an aside, Christy Wolf and Dawn Lawson answered questions regarding alternative livestock options (goats and sheep as opposed to cows), various economic aspects of grazing, and the constraints these economic considerations place on management.

## **Synthesis and Group Discussion**

Carolyn Enquist reviewed the activities of the two groups, starting with afternoon of Day 1, and then described the overlap between the two groups in terms of riparian management, fire management, species management, and grazing management.<sup>2</sup> This resulted in a combined wire diagram that the group as a whole commented on (Figure 2). Carolyn invited the group to think about the need for adaptive management and the need to reconsider the tenability of our objectives in the future. She also invited the group to consider the proposed actions in the context of the categories of resistance, resilience, and triage.

---

<sup>2</sup> The powerpoint slides for Carolyn's presentation are included in Appendix E.



**Figure 2. Potential actions for initial climate scenario for CSS and Riparian Habitats on Detachment Fallbrook.**

The group then discussed the difficulties encountered by regulatory agencies when considering species shifts and local extirpations. Peter Beck stated that, at some point, regulatory agencies will be faced with a question of priorities, and decisions will need to be made concerning the relevance of alternative actions in light of those priorities. Dawn Lawson stressed the overlying uncertainty regarding the causes of species decline (i.e., Is the pattern of decline a symptom of management or a symptom of climate change drivers?). Bill Berry identified the potential for climate change to stress the relationship between land managers and regulatory agencies because of this uncertainty. Dawn Lawson added that the current politics and institutional structures may push management toward actions that promote resistance, as opposed to resilience. Carolyn Enquist said that future management might need to readjust to novel species assemblages with novel targets.

Dawn Lawson shifted the conversation to address resilience, such as weed control, but added that a major institutional hurdle might be response to climate change—for example where managers are considering facilitated movement of species. Carolyn Enquist and Bill Berry suggested that reducing the non-climate stressors by maintaining ecological processes (water and soil) might be the best way to build in resilience to climate change. Carolyn Enquist summarized different hurdles to adaptation planning, including policy barriers, institutional barriers, installation vs. region-wide issues, and whether managers will see a benefit to addressing climate change given the legal and institutional constraints on natural resource management.

David James broadened the footprint of the discussion by discussing DoD-wide initiatives to watch species across the United States with the potential to become listed, and he solicited information on species that might be candidates for vulnerability assessments to address climate change in the context of other threats.

Bill Berry stated that military natural resources programs have, for some time, been managing for non-mission-related stressors because land managers effectively have little control over mission-related stressors. He questioned whether, by focusing efforts on restoration, exotic control, and other non-mission-related stressors, perhaps land managers have already begun the process of building in resilience to climate change. These discussions were followed by a break, and then Carolyn Enquist began a discussion related to strategic monitoring.

## Adaptation Planning

This session was moderated by Carolyn Enquist and began with an introduction to the topic of strategic climate-informed monitoring (SCIM), or “climate smart conservation.”<sup>3</sup> Carolyn discussed an approach to effective adaptive management that addresses the temporal dimensions of ecological systems—not only the spatial dimensions. “Phenology” is the study of the timing of life cycle events in plants and animals (e.g., leafing, flowering, fruiting, aestivation, hibernation, migration, and breeding). As described further below, phenology can be a key indicator of climate change.

*The following section is an edited transcript of Carolyn Enquist's presentation.*

## Strategic Climate-Informed Monitoring

Individuals from the NWF [National Wildlife Federation] and USGS [U.S. Geological Society] (and others) are leading the charge for what is becoming widely known as “climate smart conservation.” The first step in this planning-oriented process focuses on providing guidance for conducting vulnerability assessments. This is followed by presenting general principles for addressing planning through the lens of climate change. Although monitoring is an important component of this process, it still requires further conceptual development relative to climate smart conservation (e.g., what makes it different from “conventional” monitoring). In this workshop, we are referring to this emerging topic as “Strategic Climate-Informed Monitoring.”

Ultimately, the goal of SCIM is to provide information for understanding climate vulnerability and helping implement effective adaptive management (i.e., this helps us to identify and evaluate implemented management actions). In particular, these approaches should be capable of informing how we might need to adjust management strategies to accommodate climate and environmental change and still meet our objectives. A typical first question is “What aspects of our ecosystem do we need to be monitoring?” (talking more broadly than Detachment Fallbrook). Pereira et al. (2013) recently published a paper about an Essential Biodiversity Variable (EBV) process inspired by a set of

---

<sup>3</sup> The powerpoint slides for Carolyn's presentation are included in Appendix E.

essential climate variables previously adopted by Global Climate Observing System (GCOS) of the United Nations Framework Convention on Climate Change (UNFCCC). The Group on Earth Observations Biodiversity Observation Network (GEO-BON) developed these to support implementation of an ancillary set of global standards for biodiversity monitoring. This could be a starting place for deciding which biodiversity variables to monitor.

What are other considerations and motivations for doing climate-informed monitoring? These may include the detection of trends for scientific discovery, answering a specific question, or for evaluating our management strategies. We may decide to identify a set of climate-sensitive indicator species or metrics as surrogates for the larger system to focus and/or optimize our monitoring. This also may be important from a cost (funding) perspective. How we design a monitoring program will relate to these considerations, particularly to the timing and frequency of the sampling regime. We also would want to consider other variables that may help us detect and describe change. For example, we might co-locate weather stations and take local soil moisture measurements, in addition to our biodiversity variables.

Many questions also arise on the logistical front. Who does the monitoring? Where do you put it and ultimately how do you use it? A lot of monitoring data out there are underutilized. How do we ensure that the data are maximally used (more than only for the main purpose for which they were collected) and are used to inform our management?

With all of these questions in mind, I would like to introduce the idea of phenology as being one of the key EBVs associated with climate-informed monitoring. “Phenology” is the study of the timing of life cycle events in plants and animals (e.g., leafing flowering fruiting, aestivation, hibernation, migration, and breeding). “Seasonality” might be the abiotic analogy to phenology. Since working with NPN [National Phenology Network], I have a new appreciation for considering the temporal dimensions of ecological systems—not only the spatial dimensions. The phenological changes that we are seeing in response to climate change are well documented (reference to Elsa Cleland’s talk and the work she is doing). You could argue that phenology cross cuts all of those EBVs and also scales from leaf to globe. Agriculturalists have been thinking about this for a long time (centuries even). At the broad scale, the metrics “growing degree days” and the timing and duration of freeze events are particularly informative. For example, species populations whose leaves emerge earlier may be susceptible to late freezes and suffer damage or death. At the level of landscapes and regions, the timing of peak flow and snow melt, growing season length, and fire season timing and duration are also key phenology-linked metrics.. At the species level, timing of leafing and bloom can influence timing of management strategies. For example, when do certain migratory species utilize the habitat in your particular management area? In short, phenology is a key indicator of climate change (EPA 2012) that has been described as one of “the simplest processes in which to track changes in the ecology of species in response to climate change” (IPCC 2007).

Shifting gears a bit, let’s think about how phenology monitoring relates to the adaptation planning process that we are implementing during this workshop. Recall the ACT Framework steps from Cross et al. (2012). Steps 2, 3, and 4 can be informed by phenological information. These include informing

vulnerability assessment (as a measure of sensitivity and adaptive capacity), identifying the optimal timing of management interventions, evaluating the effectiveness of adaptation actions, and ultimately adjusting the timing of these actions. In short, phenological monitoring can be viewed as an effective response to climate change.

There is the example of a now classic European study (Both et al. 2006, Nature) that describes a phenological mismatch between the arrival of a migratory bird species (the Pied flycatcher) to its feeding and breeding grounds and the peak abundance of its primary food source (the winter moth). This resulted in a decline in the population abundance of the bird. On the level of management, this can play out with ground-nesting birds; the timing of nesting can influence when you choose to mow. The timing of prescribed burns may also need to be adjusted in the future, pending water availability and the status of fine fuels. This also could be extended to decisions about when to apply herbicides. These are just a few examples, or food for thought, that may relate to Detachment Fallbrook. What is important now is to develop a shared vision for climate-informed monitoring for this installation. How do we specifically bring the discussion back to Detachment Fallbrook and help Christy do her job better in light of challenges related to climate change?

## Group Discussion about Adaptive Management

A group discussion followed Carolyn's talk about adaptive management. The main theme of the discussion was how to modify existing monitoring programs to include data that will inform management and help us differentiate between the effects of climate change and other drivers. The challenge is that existing monitoring programs are often large and complex and driven by Endangered Species Act requirements which mean that they can't always be redone without negotiation with the US Fish and Wildlife Service. Even for a single species, rethinking and renegotiating monitoring programs can be a difficult and lengthy process. Changing monitoring programs ad hoc vs by programmatic review was also discussed. Ad hoc changes will certainly make sense in some cases but without programmatic review, it is likely that important opportunities will be missed.

*An edited transcript of comments recorded during the group discussion follows and identifies the speaker/participant. In a few instances, a complete comment was not audible in the recording.*

Carolyn Enquist– It makes sense to ask what kind of questions we might ask that would be informative to management.

Kylie Fischer – I have done the California gnatcatcher surveys at Detachment Fallbrook for 4 years in a row. I do them the same way each time, at the same time of the year. Last year we had a peak number of pairs. Most of the time, however, the first peak fledging period has not started and I count a lower number of pairs, 60 fledglings. Pulling out that information for the [land] manager might be beneficial over time. It may have been idiosyncratic to the year, but with continual monitoring, you may see it start to shift. It is an example of extra information that Christy could have people mining the data for.

Christy Wolf – We have a protocol for that survey; it's the same every year. I have not pulled out or asked for certain parameters like that to be identified, but it would be really easy to modify that protocol. We could go back to the last 4 years and pull it out of the reports for a headstart.

Dawn Lawson – So it seems like we should step back and identify specific questions you would like to answer. We would need to identify what could be done easily and what questions we would like answered, and evaluate whether the protocol should be changed.

Christy Wolf – (*What follows immediately is a synopsis because of poor recording quality.*) When we were discussing the shifting breeding season, we talked about shifting the start dates because of weather and other causes. We talked about the little modifications on existing protocol.

Dawn Lawson – So do you think it would be feasible to do a comprehensive review of all the monitoring actions we take or does this seem too big of an effort. When you look at all the monitoring, it seems as if a lot of money is spent and it seems like it would be a worthy investment to have a review. That review itself would be expensive and [particularly] should a statistician be involved.

Christy Wolf – I think we need to be really careful about getting too big. That has killed us on some projects. We get so wrapped around the axel with statistical complexity and it becomes paralyzing. I am all about statistics and recognize the pitfalls of not conducting rigorous tests, but sometimes it's important to keep data collection simple over time so that it's achievable. If data are collected consistently, and we see increases or decreases over time, it's not always informative to determine if the change is statistically significant. What becomes important is if there appears to be a trend (e.g., persistent downward trend in SKR; the decline from year to year may not be statistically significant, but it can still be of concern).

Dawn Lawson – Referenced the comprehensive review of Stephen's kangaroo rat station-wide mapping protocol.

Christy Wolf – Wasn't going to mention that specifically but that was painful. It is not over yet and is not going to be over for a long time. We don't have a way of getting subject matter experts on board who can truly take us from cradle to grave and then every single time you want to implement it to have that continuity. Sometimes it extends to needing to have specific software programs to analyze the data. I mean it goes from top to bottom. In terms of level of complexity we have to be really, really careful about that because we can grind ourselves into no action being taken.

Dawn Lawson – That is a really good point you mentioned about making things so complex that nothing happens. But without looking at everything and thinking about it in a comprehensive way, you could miss some good opportunities.

Christy Wolf – I do think that it is very helpful to identify the climate change lens and certain monitoring parameters of interest and then I can review the program because I know what we do monitor fairly

readily. I could see what could dovetail well with our existing program and what is way out of the scope of what we do, so that it would be a whole new program.

With a new initiative, we would have to look and see what the priority would be. That being said, even if it does dovetail with an existing program, there may still be a lot of questions to sort out. Take the LTETM (Long-Term Ecological Trend Monitoring Program) as an example. We've not been implementing the LTETM in recent years and while I do think it has a lot of problems, I would love to see it get off the ground again. But the LTETM would also benefit from some higher level of analysis. What would we be able to glean from the data if we were to project another 20 years of data collections? What questions could we answer?

Chuck Black – We (Miramar) have an LTETM program and have had several rounds of data collection (plants, birds, herps and it suffers from the same problem as the vernal pool data in that precipitation drives so much of population dynamics and varies highly year to year. It is a huge contracting effort to get it going and includes: reptiles, birds, vegetation and deer surveys and if you have a really bad or good year and you only take it every 5 years you could get a warped perspective of what is happening.

Christy Wolf – Detachment Fallbrook was supposed to have more frequent sampling where we have ~ 50 plots with a subset that would be done annually and then others less frequently (either a 2-year or 4-year rotation). It helps in a way by increasing the sampling frequency, but it actually made the analysis crazy because you have non-comparable years. We never wrapped our arms around if this was even a good approach, and then I haven't been able to get funding to continue it in recent years anyway. But I do think that there is something there that could be salvaged and kept manageable enough (e.g., with a small component of sampling every year). And we could possibly add variables in the context of our working group objectives (e.g., measurements that let us take a look at sycamore recruitment, which may not be relevant to the plots that we are monitoring annually, but it could be a relatively easy venue for me to contract an option that lets us take a look at recruitment every few years). That's just an example. I think that program could benefit from someone smarter than me spending some time on it.

Carolyn Enquist – I was going to ask about the LBVI [least Bell's vireo], getting back to the management objective, and there is the water component, the species component, and the habitat component. Along those lines, there is increasing water availability improving habitat and the ultimate goal of what is happening with the birds in terms of benefiting the species. So I might just throw out if we want to focus this discussion a little more relative to answering questions related to that particular management goal, it might get us a little further as to what would you need to do. What is the information you need to reach that objective? What are the monitoring needs and how might they be achieved?

Christy Wolf – To respond to that, we did identify things that we are doing. You had the water availability, habitat availability, and the bird itself. We do monitor two out of the three. We don't monitor water availability, but indirectly we can see the effect of water availability. It is hard to know for sure the effects, since it is an unmeasured variable. We do not necessarily know what is driving it, but composition and distribution of vegetation and habitat suitability for the LBVI let us keep a finger on

the pulse of the population. What we talked about in our group, which was a good perspective for me to consider, is what can be gained from the snapshots of other monitoring venues (e.g., LTETM, vegetation mapping). For example, instead of just mapping the extent of LBVI habitat quality every 5 years, monitoring can include variables such as sycamore recruitment or mortality as a means to look into the future. Currently, when we do our vegetation mapping, we don't look at age class or do that fine-grained level of assessment. It might be too much to pull in those variables into habitat or vegetation mapping, but we could possibly incorporate it into programs like the LTETM. I think it is not at all unrealistic.

Dawn Lawson – In trying to figure out the cost benefit of that, how do you pick the one to do and is it as much as saying we are going to try to move into this ground of climate change adaptation planning and we are not going to go back and do everything and do things as piecemeal? I am afraid to do things piecemeal because there are inefficiencies in such an *ad hoc* approach in terms of recruitment. How do we prioritize? The California gnatcatcher was a good example because it sounds like very little extra effort and we get extra data.

Christy Wolf – Level of effort is an important criterion for prioritization. Not kidding, sort of like low-hanging fruit gets priority because it is low-hanging fruit – especially if there is a huge payoff or benefit. The challenge is figuring out what are the low-hanging fruits in terms of variables of interest. We probably won't have interesting results for a long time because of system variability, but if we had started a while ago, we may have been able to detect current trends that are potentially unidirectional.

Dawn Lawson – Do you monitor California gnatcatcher every year?

Kylie Fischer – We monitor a subset.

Christy Wolf – We monitor within a subset of polygons – it supports an INRMP objective for population monitoring between comprehensive 5-year station-wide surveys.

Peter Beck – I actually like Dawn Lawson's idea about evaluating the entire monitoring program at some scale. I don't mean that in a sense that we have to go through this and torture ourselves, but I think it is a good idea to look at each one of your monitoring programs and establish driver and priority. There might be things that you can add on to a program that won't cost much more but give you some information, but I wouldn't do this in a haphazard manor. That is what my concern is.

Dawn Lawson – Maybe I was wrong in saying that we need to bring in a statistician but we do need a comprehensive review that isn't going to bog us down.

Christy Wolf – I was hoping that these 2 days would get me there... or at least provide insight into the relative value of our different monitoring programs within a climate change context.

Peter Beck – We need to consider the trade-offs.

Dawn Lawson – Another thought about low-hanging fruit that I had mentioned to Christy. We have maps and where we control invasive species, and there could be good information in that effort. I don't know if there are estimates of numbers, phenological states, etc. Perhaps we can get some useful data out of that.

Christy Wolf – That is still getting away from Peter [Beck's] idea of evaluating the whole program. What would benefit us is a murder board kind of level of infusion of this kind of venue. Few people have the luxury of spending a week doing this – how to get there?

Dawn Lawson – We could take the list of monitoring programs to start and do the murder board.

Peter Beck – I know some and maybe quite a few have regulatory drivers through the ESA [Endangered Species Act]. But these requirements can be an accretion over time. So maybe you have the Fire Management Plan, the base has the riparian Biological Opinion, and these things were built at one time and maybe they don't really make as much sense anymore.

Bill Berry – For the most part, with some exceptions, they are not set in stone.

Peter Beck – We have touched on it with Camp Pendleton and also with Fallbrook. We can revisit these things and ask what is the big picture, and whether is it important to still do them. And, if so, is it important to do them in the same way. Certainly I am not an advocate of switching horses in mid-stream but at the same time if you don't have a necessity to do things and LBV surveys are impacting other things that are more important by spending money and capital, then we could evaluate if we should be shifting whole monitoring program.

Bill Berry – What are we monitoring for? What are the triggers? I have been in situations where you just monitor the extinction of the species. One of the things I have struggled with is when we have been doing project planning and the project proponent says they can't do breeding season avoidance. What ends up getting said is "We have to do work during the breeding season but it will be ok because we will have a biological monitor." In essence, it is okay if you are going to have a biological monitor. The question is What is the biological monitor looking for when they are out there? If they see what they are looking for, what are you going to do? If it is just the fact that someone is standing out there recording the impacts, and you can just have those impacts, then it is not doing any good. At the same time, if you know from experience that the species that you are dealing with is going to arrive and will be x feet from your activity, why are you going to go ahead and approve the activity and the biological monitor when you know that the activity will be stopped?

Christy Wolf – I do think there is a big difference between natural resources program monitoring goals and objectives and biological monitoring.

Bill Berry – That was just an example knowing what you want to get out of monitoring before you start to do it.

Christy Wolf – I feel very much that we have done that at Fallbrook. I have very deliberate objectives for the annual monitoring. For example, I deliberately did not want to do point counts because I wanted to be looking at a population parameter with the statistic being pairs of birds, as opposed to point counts that have a presence/absence value but you don't know anything else. I also wanted more distribution information, so we have a sense of habitat utilization, especially within key locations of interest. For the vireo, we annually survey all high-quality habitat within the interior of the Detachment. For the California gnatcatcher, we monitor utilization within polygons specifically chosen to meet two objectives: (1) higher priority California gnatcatcher conservation areas due to higher population concentrations; and (2) mission support so that our annual monitoring directly supports avoidance and minimization of mission projects. (Both programs also provide locality information on other species of concern, including coastal cactus wrens.) For these species, I feel really good about the monitoring objectives and the feedback the data provide. Those are two success stories for our monitoring.

Christy Wolf – With our ARTO [arroyo toad] I don't always see the point of some of the river monitoring. We are a little redundant with Camp Pendleton on some things, so my future vision might entail more partnering than we have done. In recent years, we have focused our effort by trying to get a handle on upland habitat utilization. The upland studies will ultimately serve the mission as well as possible proactive ARTO management. Currently, the upland surveys are mostly helping document absence in several areas—and involves just chipping away over time, in different rain years, until we really feel confident we have exhausted those surveys. I think we are getting to the point that we don't have that much more chipping away to do before we get a picture we can feel reasonably confident about.

Christy Wolf – With respect to SKR, I feel the monitoring has provided us valuable feedback on relative population trends, informing management decisions, and as long as it is a listed species for which we are responsible, I would fight to retain the program. We have kept it at a reasonable cost. If it seems expensive, it is because I add a lot of options on that don't really need to be funded. At the end of the year, if there is extra funding, they get funded. So it looks like it costs more sometimes but it doesn't have to. I guess my main point is that we do use a lot of the monitoring data that we collect – whether for general trends that may indicate the relative stability of a population, for avoidance/minimization during mission support or sometimes for incidental observations (e.g., potential effects of cattle grazing, sighting of banded birds, or a new invasive species).

Dawn Lawson – Okay. Where are we going and how can we do something with this? It seems to me that we don't have time to do it today, but a useful exercise would be to list the drivers, the frequency of monitoring, and whether we thought we could add (or extract from the current protocol) phenology information. Identifying opportunities to get phenology information would be one sort of cut we could do. That could be an INRMP recommendation when you go forward with monitoring to think about phenology—not kill yourself or spend a bunch of extra money but as Peter Beck said about not layering monitoring requirements on one project at a time so it doesn't make sense.

Peter Beck – They are going to end up this way. It is the way things work, but we can always step back and create more value and simplify if possible. If there are limited pots of money, let's redirect it but in

a way that makes more sense, that addresses the issues that we are dealing with now not the issues that we were dealing with 20 years ago.

Christy Wolf – I totally agree that it is important to take a step back and ask “Is this serving a value?” I do feel that in the past, data were collected on certain things in ways that didn’t maximize value.

Peter Beck – I think your LBVI and California gnatcatcher programs are evolving over the last couple of years and so they are not the ones that I would really question.

Christy Wolf – Where I was going with that one was that we are in the throes of evaluating the grazing management program. We struggle with some of the data that were collected, so we are currently trying to reevaluate the monitoring program and develop a little bit more of a robust protocol. But therein lies the challenge – there are a lot of important questions, including variances in phenology from year to year, and monitoring for feedback that informs management in a timely manner can be tricky. The challenges can be daunting, but perhaps the monitoring component could be simplified.

Dawn Lawson – One of the things that I had thought of as we were building up to this was looking at the effectiveness of our management actions. NAVFAC [Naval Facilities Engineering Command] went through a process of developing a CSS restoration plan with the U.S. Fish and Wildlife Service (FWS) with success criteria in it. My understanding is that we use this plan to implement CSS restoration project so there is potentially data out there for the region on the effectiveness of CSS restoration through endangered species requirements and maybe other habitat types as well. It would be interesting to think about evaluating that to see if you could track effectiveness over time. If the climate really changes and CSS is declining, you would maybe expect to see that the success of the projects would decline. Because I am pretty sure everyone that does CSS restoration reports cover by species and maybe not always density but probably always cover.

Peter Beck – There would be a metric but whether it is measured and reported consistently would be questionable. Probably fairly consistent with the military if a lot of it was run through that plan but would not necessarily be true for restoration beyond the military borders. Unfortunately, there is not consistency of that requirement. I really don’t know. You might get apples and oranges if you start comparing things beyond the military borders. Not to say that they are worse or better there might be some reporting that can really be subject to knowledge and oversight of the biologist from the USFWS side and the quality of the biologist on the other side.

Dawn Lawson – That kind of a meta-analysis is messy because you are taking a bunch of different studies and that adds variability, but it would be interesting to keep this on our horizon.

Diane Walsh – Mentioned Deborah Bieber’s CSS project outside the levee (5-year monitoring requirement).

Peter Beck – A lot of CSS [habitat] has been restored on Camp Pendleton.

Bill Berry – Some works better than others; it depends on the contractor, the year (weather wise) [and the site]. There are a lot of sources of variability.

Dawn Lawson – You could go back and get weather data from existing weather stations.

Bill Berry – But even if you could glean that, you can't just put off your restoration project until a good year was projected.

Dawn Lawson – I was actually thinking of something different. I was thinking of evaluating whether CSS restoration was becoming ineffective, not about timing it to conduct restoration in a suitable year.

Bill Berry – With your LBVI monitoring thinking in terms of phenology, certainly with Camp Pendleton the monitoring emphasis has been on the number of singing males or numbers of pairs as the primary parameter of the success of the program. But if we are looking at climate change, then do we look at “When is the first migrant arriving”?

Peter Beck – That was one of the things Kylie had suggested—the timing of breeding – the initiation of breeding.

Bill Berry – When is the first nest and the last nest? Those kinds of things might change through time. I think some of that may be getting collected anecdotally, some has to happen now before we start the survey. The birds aren't here now so we aren't going to start the survey, but you don't necessarily collect that so you can look back on it 3 years later (i.e., we didn't start until a certain date because the first bird arrived on X specific date). Those are the things we maybe need to start collecting. So it is a paradigm change to start doing LBVI surveys before the LBVI are here.

Peter Beck – When I used to do that on the San Luis Rey river, that was what I consistently did. I walked sections of the area that I would survey early in March before the regularly anticipated time, so I knew when the early birds were arriving. That is not always feasible getting monitors out in the field once that potential breaks down that is a challenge. You could build that into your monitoring program.

Bill Berry – It may not have as much impact to Weapons station program but at Camp Pendleton, there is a lot of focus on the breeding season and associated restrictions. If through climate change, we are going to see a shift in breeding season, we are going to need to understand what that is because that has management implications.

Christy Wolf – I totally see that. I think there would be a lot of value in detecting those shifts. But the devil is in the details: for example, if it needs additional survey passes to really tie that variable down, it is no longer in the realm of additional data someone could collect when they are already out in the field. Additional survey passes adds additional costs. (Kylie Fischer later noted that she was thinking a better parameter might be the shift in “peak” fledging, for example, which wouldn't require additional passes, or identification of the first arrivals.)

Carolyn Enquist – Asked about graduate students to reduce the cost of monitoring, and there was discussion on the problem with that and listed species and required permits and the effort in general that it takes to manage volunteers.

Bill Berry – Noted that it costs Camp Pendleton about a million to survey for California gnatcatcher on Camp Pendleton; it is primarily labor that drives the costs. Where we get benefit from graduate students are more along the lines of roadrunner study or surveys or cactus wren surveys – up-and-coming species. It is a one off thing not an ongoing program.

Peter Beck – Applies more to short-term programs

Bill Berry – Volunteers are something that we struggle with. If you have a volunteer program you would have to have a volunteer coordinator.

Christy Wolf – I agree; volunteers requires more work in recruitment, vetting, oversight, and management. It can also be problematic using volunteers if you need a rigorous protocol implemented.

Peter Beck – Most useful in limited scope project that adds on to a monitoring program but not the basic program.

Christy Wolf – We try to take advantage of these one off opportunities (e.g. USGS or SDNHM [San Diego Natural History Museum] studies). Basically, if someone comes with their own question and it's compatible with the mission and program objectives, we try to accommodate it. It can be a win-win, as we gain more data and insight about our resources. Coordinating logistics is not trivial but we can usually do that; we just don't necessarily have the time to work on developing questions and scopes.

## Closing Comments

The organizers of the workshop thanked the group for their participation.

*An edited transcript of the closing comments is found below.*

Carolyn Enquist – It has been a real pleasure working with you all. It has just been a fantastic workshop. You all were very open minded and brought your expertise. It has been one of the best groups I have worked with. You all have opened your mind to it and didn't resist. Laughter.....

Dawn Lawson – So I think it has been a great workshop and we have gotten out of it what we need to try to formulate an adaptation plan for Detachment Fallbrook and to work on the process and to think about it at a higher level. Going through the working groups was an absorbing exercise. I didn't really have a chance to reflect on what we generated. Would you [working group participants] be able to take an hour to look at it and reflect on whether the process missed any important issues? We will start cleaning up the lists and models from the working groups and try to do that as quickly as possible. The next step then will be to develop a specific adaptation plan for Christy and a more general process and strategy.

Christy Wolf – I echo what Dawn and Carolyn said. And would like to thank everyone. It was not always easy. I had some trepidation going in. But I benefited just from the discussions and am hoping that the other installations benefited – especially where they may have similar themes and common solutions. I feel like we just scratched the surface in many ways. We chose one objective, a few drivers, and narrowed our focus each step of the way. There were some good ideas that we didn't have time to discuss. But the process was robust at the end of the day, although aspects could be a little maddening (e.g., "that's not a driver, it's a pressure"). How else would I do it? I'm not sure. It provided a structure at the end of the day. If we could plug-and-chug for several more days, I think we would have exhausted the issues and have developed an even more well-rounded set of themes. But even 2 days was still a considerable commitment for most people. I think we maximized the limited time well by breaking up into the two working groups, but I wish I could have been in both groups. So, thank you. I really appreciate everyone's 2 days out of their crazy busy schedules.

## Workshop Evaluation

At the end of the workshop, participants completed a workshop evaluation. Overall the comments were very positive though specific suggestions for improvement were provided. Most participants from military installations thought the exercise would be very useful to their facility.

The most frequent comment was a suggestion to provide selected materials to workshop participants in advance of a workshop, so that participants are more informed about the topics to be discussed.

*The following is a summary of the workshop evaluation forms completed by workshop participants at the end of the 2 days.*

### Question #1

***Did you think a climate change adaptation planning process would be a useful exercise at your installation and for your INRMP?***

| Not at All | A Little | Moderately | Very Much | Not Sure |
|------------|----------|------------|-----------|----------|
| 0          | 1        | 2          | 10        | 1        |

#### ***Please Explain***

- I am not attached to an installation and I do not participate in the drafting of an INRMP. However, I think that the kind of engagement that would result from this type of effort could/would be very useful in at least framing the questions, if not the answers.
- The workshop highlighted topics that will eventually need to be considered. Didn't realize any immediate benefits. It was beneficial to hear about climate change predictions.
- This is N/A for me personally, but I think this was useful and productive.
- This kind of interdisciplinary and structured thinking about local installation problems provides uncommon insight for INRMP strategies
- Projected change will clearly affect species we have.

- N/A NAVFAC.
- This was done at the installation where I serve so this is almost a N/A response. The workshop was useful for evaluating natural resource management both in and outside of the context of climate change.
- Background and overviews provided great info and opportunity for review and new information.
- Without this type of planning and consideration, climate change planning will continue to get "kicked down the road."
- I think this is a good experience for each installation to go through to help them look at climate change differently.
- As climate change gains more attention as a driver of natural resource sustainability, it would be smart to have brainstormed the implications at a local level early on.
- But I don't work at an installation! I think this is a great process.
- My installation is also geographically located in Southern California and we share some species and riparian habitat.
- Although I do not work for the military, I think it is useful to start the process of thinking about and estimating changes under climate change and what might be done to address these changes. It's always good to have a plan.
- We have shorelines and even a small rise in sea level could have a significant effect. Going through this process makes you realize what you can and can't do and may help to come to a more practical solution. If you don't plan, you get nowhere.
- As Detachment Fallbrook was the focus, I can say the workshop was a very useful exercise. Without having climate change subject matter experts on the installation, it's difficult to consider natural resource management in a climate change context. It's also difficult to be a SME for all areas of responsibility in natural resources, so it was very helpful having an opportunity just to brainstorm the possible effects with colleagues and SMEs in the region. This is not a luxury we often afford ourselves, but it's a great opportunity to develop a more informed longer term vision as we continue to work on the here and now demands.

## Question #2

***Which section of the workshop was least and most useful to you and your work? Please evaluate 1 (least) – 4 (most). (Note: A number of people appear to have ranked these rather than evaluating them independently.)***

### ***Summary***

| <b>Presentations<br/>(Day 1 AM)</b> | <b>Breakout 1<br/>(Day 1 afternoon)</b> | <b>Breakout 1<br/>(Day 2 morning)</b> | <b>Synthesis &amp; Next<br/>Steps (Day 2 afternoon)</b> |
|-------------------------------------|---|---------------------------------------|---|
| <b>3.2</b>                          | <b>3.2</b>                              | <b>3.0</b>                            | <b>2.5</b>  |

### Question #3

***Please evaluate the plenary presentations: Poor = 1 Okay = 2 Good = 3 Excellent = 4***

#### ***Summary***

| Background on<br>INRMPs | Climate Change<br>Projections | Ecological<br>Implications | Overview of Adaptation<br>Planning |
|-------------------------|-------------------------------|----------------------------|------------------------------------|
| 3.3                     | 3.6                           | 3.5                        | 3.5                                |

#### ***Comments on presentations (Note: This was not in the evaluation form, but several people answered.)***

- Both the climate change and ecological effects talks went too fast. The presenters knew the data, but I needed a bit more time to internalize the data.
  - All were helpful. Couldn't hear Elsa. I think we would have (illegible comment) better by narrowing to 2 drivers - Increased temperature and overall decreased precipitation.
- Too rushed – Need longer/more diverse presentations with more potential to have a dialogue with the speakers.
- Presentation length and information content was good.

#### ***What additional information would have increased your understanding of climate change, the process, and exercises?***

- Read-ahead material at least 2 weeks prior to the workshop.
- Information associated with how regulating policy might change (e.g. T&E species conservation by USFWS).
- Clear definitions and more defined relationship between the charts and tables.
- More scientific articles in handout book?
- No additional information noted.
- Climate change projections were probably most useful—laid the groundwork. Listed species specific implications would be an ideal presentation (if information is available).
- References to articles ahead of time. Well done!
- Define term “phenology” and its importance in the climate change arena.
- Define clearly driver, effect, pressure, management strategy and all headers in Tables 1 and 2 [in Appendices C and D] so it is clear what we should be putting in each row.
- (1) More specific examples of seeing the effects of climate change; (2) Using one climate change prediction scenario for the exercise; (3) Defining the conceptual model components or establishing a set (of drivers) to work from.
- I would have benefited from having background materials in advance of meeting (to be ready to participate) and more background/training on conceptual model—I think people were a little clueless at first.
- More discussion and presentation on potential climate change scenarios and ecological consequences at a local and habitat-specific level.
- It would be helpful if we were dealing with facts and not models but unfortunately that isn't possible.

- I'm not sure honestly, but I can say that some of the material sunk in better than other aspects of the material... (I did have to leave the workshop 2 times during some of these talks.)

## Question #4

***In your estimation, what would be the top barriers to implementation of the proposed actions from the workshop?***

- (1) Demonstrating an impact on mission (more than presuming an impact); (2) decision makers short-term focus (before retiring or transferring); (3) some questioning that climate change is happening or that it is important to think about (still); 4) funding constraints/limited manpower.
- (1) Funding; (2) politics.
- (1) Institutional.
- (1) Funding.
- To meet the level one- compliance funding threshold.
- Prescribed burns would be very difficult to implement, specifically on Detachment Fallbrook. It is a hot button issue with the ordnance. Other than that, most actions identified were modifications to existing programs (grazing, weed management) and would likely be able to be implemented. Putting it in the context of climate change, however, may make them more difficult to implement.
- (1) This is very difficult work; (2) impact is long term, not necessarily short or mid-term impact; (3) adaptation work is difficult to fund—it requires an examination of costs of doing nothing versus investing in adaptation; (4) level of uncertainty while not necessarily high, is still a barrier to think about—personnel barriers. We have to figure it out and do it.
- (1) Time; (2) funding.
- (1) Uncertainty; (2) long time frame; (3) continued emphasis on T&E species compliance in competition for natural resource management resources (funds and billets).
- (1) Funding; (2) approvals—buy in from management; (3) magnitude
- (1) ESA laws and regulations; (2) politics.
- Lack of funding.
- For those of us on military installations, we often have CO's who simply do not believe in science, much less believe in climate change. However, with the President's recent pronouncements, they will be forced into it, but we will need required guidance from region and HQMC [Headquarters Marine Corps] in order to fully implement.
- (1) Cost; (2) uncertainty (of climate change effects and solutions).
- (I'm thinking mostly of the recommended fixes to the interior streambeds for this question, which is a fairly large, complex project that requires permitting, expertise, time, and a lot of money) - staff time.

## Question #5

***In your estimation, what would be needed to overcome these barriers?***

- Not sure, but I would think at a minimum the following would help or be necessary in overcoming barriers to implementation: (1) buy-in; (2) dedicated funding; (3) management support (especially directive from CNIC [Commander, Navy Installations Command]/NAVFAC HQ [Naval Facilities Engineering Command Headquarters]).

- (1) More clear proof of a local change (difficult); (2) Developing a position explaining why adaptation is needed sooner than later (not sure this can easily be done at the local level).
- Modification of priorities, personnel higher up.
- More integration of installation's objectives with chain of command—evidence that implementation would favorably impact military is missing.
- A nexus to T\*E species compliance—potential for new listed species/ critical habitat designation as a result of population threats from climate change.
- I think I captured this above.
- Dedicated requirements regulations and education.
- Patience and perseverance.
- (1) Strategic planning; (2) look for opportunities to mine information from existing efforts.
- Beyond me...
- Money!! Support from higher level decision makers.
- Directives from HQMC to integrate climate change into its processes.
- Regular revision and recalibration of impact models (for installation) and necessary actions to minimize impacts.
- It seemed like the proposed action in the riparian group was impractical for LBV because FB creek doesn't contribute enough to LBV to make it worth the investment of funds to reverse the channelization.
- I don't see that we'll ever overcome the staffing issue at Fallbrook or political will, but the best way to attempt to overcome this is to break the project up into smaller components that can be chipped away at over time. For some things, we can see to incorporate elements of the monitoring, for example, into existing monitoring programs with a few tweaks.

## Question #6

***Do you have suggestions for improving future climate change adaptation workshops? Any feedback on materials, activities, information, timing, etc. is welcome!***

- Improvements might consist of: (1) the preliminary technical presentations were perfect and probably crucial to any success. Additional case study results as they become available would be equally useful, especially if directly applicable to the installation where the workshop is being held; (2) read-ahead material.
- Have a second case study location with different land uses but similar resource issues, unless the workshop has a specific installation focus.
- Clear definitions would be very useful.
- Specific examples of implemented programs, models of practical applications affecting military missions.
- Going out to look at a riparian habitat located along an ephemeral stream that we believe is vulnerable to climate change due to current degraded condition, etc. (conducting breakout sessions from actual project areas that are identified).
- Make that sure each group has a plant ecologist and a wildlife biologist (SME) as they approach it differently. Good conversations.
- Keep it simple and stay on track with climate change. Stay focused!

- Not a suggestion, but thought it would be interesting to do it with species targets instead of (or in addition to) communities.
- The workshop was designed nicely – Fallbrook Naval Weapons Station as our case study, the goals of the INRMP. The theory and practice was easily adapted to any installation. I see the next logical step as integration into documents such as NEPA, Biological Opinions, and sustainability plans that will allow for application in routine actions.
- Some background material on climate change and ecological consequences should be provided in advance in a simple, readable format; we would all be up to speed for discussions in break-out groups.
- Some thoughts. (1) Liked both the presentations and working group—in the presentations, someone is thinking for you and in the breakout session, you have to take the information and put it together for yourself; (2) (in this workshop only two people were directly involved in the management FB) It would be better if no one had a dog in the fight or everyone had one. I was less likely to challenge one of the FB managers because FB is not my base.
- The binders were GREAT! I had to step out a couple of times, so I may have missed this if it happened, but I think it might have been useful to have spent a few minutes walking the participants through some of the material in the binders more specifically (e.g., definitions—with an emphasis on the terms we would need for the breakout session). Our group did not do the flow diagram and spent more time brainstorming in the form of lists on the white board that were then translated to the table... I'm not sure if we would have been more comprehensive in our findings at the end of the day had we populated a flow diagram (maybe?), but we were feeling tight on time and decided to cut to the chase by populating the table. It would have been great to have even more time, but 2 days was a huge investment for a lot of people. I felt like we scratched the surface (e.g., focused on just 2 resources, top 3 drivers, then top 3 strategic actions, etc.). But the process was helpful, and I was surprised by how much we did actually accomplish.

***I liked it when...***

- I liked the use of both a facilitator and a note taker in each breakout session. This worked extremely well and may have contributed greatly to the success of at least one of the two workgroups.
- The structure and flexibility were well-balanced.
- We pulled it all together in the opportunities for strategic action implementation: evaluating top priority actions considering barriers and key uncertainties.
- There were open, frank discussions. It was good to have the hardcopies of presentations in the binder.
- We worked in groups and Bill kept us on task. Great ideas, free-flowing conversation.
- Everyone participated in discussions.

***I wish you would have...***

- Limited the breakout sessions to one topic (i.e., all work together) and have Carolyn moderate/facilitate the discussion/effort. This would keep effort on track, reduce frustrations, and let the SMEs remain SMEs or, if two groups are desired, have an additional facilitator with similar skills to Carolyn.
- Had a climate change expert in each group to keep that focus in the forefront in our discussions when we got off track.

- (1) Kept climate change drivers in front of us at all times; (2) received feedback from the two working groups at more intervals during exercise. For example, after drivers were developed:
  - Had representatives from the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers. While I recognize that your climate change study is species focused, a look at air quality (GHGs) and water quality and those impacts would have been a complete picture. Having added a weather segment (which was excellent), a natural follow on would have been water.
- Provided more background material in advance.

## References

Both, C., Bouwhuis, S., Lessells, C.M. & Visser, M.E. 2006. Climate change and population declines in a long-distance migratory bird. *Nature* 441:81–83.

Cayan DR, Maurer EP, Dettinger MD, Tyree M, Hayhoe K (2008) Climate change scenarios for the California region. *Climatic Change*, 87, S21–S42.

Cross MS, Zavaleta ES, Bachelet D, et al. 2012. The Adaptation for Conservation Targets (ACT) framework: a tool for incorporating climate change into natural resource management. *Environ Manage* 50: 341–51.

IPCC (2007) Climate change 2007: impacts, adaptation and vulnerability. contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, p 976.

Pereira HM, Ferrier S, Walters M. et al. 2013. Essential Biodiversity Variables. *Science*. Vol 339: 277-78.

United States Environmental Protection Agency (EPA). 2012. Climate Change Indicators in the United States. Office of Atmospheric Programs, Climate Change Division, with support from the Office Research and Development and the Office of Water. Available online at:  
<http://www.epa.gov/climatechange/science/indicators/download.html>. Last accessed 13 January 2014.

United States Fish and Wildlife Service (USFWS). 2003. Biological opinion (FWS-SD-3506.3) of the Fallbrook fire management plan, Fallbrook Naval Ordnance Center, California. December 2003. Carlsbad, CA.

Page Intentionally Blank

WORKSHOP SUMMARY

# APPENDIX A

---



## Workshop Agenda

Page Intentionally Blank



## **Facilitating Climate Change Adaptation in Naval Weapons Station Seal Beach Detachment Fallbrook's INRMP, San Diego County, California**

**Workshop August 28<sup>th</sup> and 29<sup>th</sup>, 2013**

### **Goal:**

The goal is to use an adaptation planning framework to develop management and monitoring strategies and a process to facilitate climate change adaptation into Integrated Natural Resource Management Plans (INRMPs) within the context of the military mission and existing threats and management.

### **Objectives:**

- Provide information about the observed and projected effects of climate change in the Southern California region.
- Introduce a framework for installation-level climate change adaptation planning within the context of existing management (i.e. INRMP).
- Develop hypotheses for effects of climate change on:
  - Coastal sage scrub and riparian habitats in western San Diego County; and
  - Existing management strategies for these habitats.
- Identify strategic actions to reduce potential adverse effects of climate change on species and ecosystems.
- Identify strategic climate informed monitoring approaches.
  - Review ongoing biological monitoring efforts to determine utility in evaluating hypotheses of change.
- *Time permitting*: Identify opportunities for regional versus installation-level strategic action and how work at both levels can support and reinforce each other.

### **Desired Outcomes of Workshop:**

- Agreement on conceptual ecological models for coastal sage scrub and riparian ecosystems.
- Identification of practical adaptation strategies that can be implemented by managers to build ecosystem resilience and support the military mission.
- Identification of information gaps.
- Development of a shared vision for a strategic climate-informed monitoring approach.
- *Time permitting*: Identification of regional vs. installation level planning and management opportunities.

## Schedule:

### DAY 1 MORNING: Intros and Education/Background Info

| Time        | Topic   | Presenter  |
|-------------|---|--|
| 08:00-08:30 | Welcome and Introduction  | Christy Wolf (Det. Fallbrook) and Dawn Lawson (SPAWAR SSC Pacific) |
| 08:30-09:00 | How INRMPs work and Det. Fallbrook NR program   | Liz Kellogg (TDI) and Christy Wolf (Det. Fallbrook)                |
| 09:00-09:45 | Future climate  | Dan Cayan (UCSD)   |
| 09:45-10:00 | Break   | ----   |
| 10:00-10:45 | Overview of ecological impacts from climate change  | Elsa Cleland (UCSD)  |
| 10:45-11:15 | Adaptation Planning   | Carolyn Enquist (NPN)  |
| 11:15-11:30 | Implementing Adaptation Planning at Det. Fallbrook (overview of how the workshop will unfold) | Robert Wolf (TDI)  |

**LUNCH: 11:30—12:30**

### DAY 1 AFTERNOON: Conceptual Models and Adaptation Planning Working Groups

| Time        | Topic                       | Group Facilitators              |
|-------------|-----------------------------|---------------------------------|
| 12:30-16:00 | Group 1: Coastal Sage Scrub | Robert Wolf & Brenna Vredevelde |
| 12:30-16:00 | Group 2: Riparian Woodland  | Bill Wild & Anna Kellogg        |

#### DAY 1 OBJECTIVES FOR THE TWO GROUPS:

1. Review management objectives(from Det. Fallbrook INRMP and Wildland Fire Plan)
2. Refine draft conceptual ecosystem model (includes conservation targets, ecological drivers, threats and management)
3. Assess potential effects under climate change by completing Table 1.
  - a. Identify which existing monitoring activities are relevant to hypothesized effects

### DAY 2 MORNING: Working Groups Cont.

| Time        | Topic  | Group Facilitators                          |
|-------------|--|---|
| 08:00-08:15 | Check in on working group progress and review group objectives | Carolyn Enquist (NPN)                       |
| 8:15-11:30  | Group 1: Coastal Sage Scrub (break as needed)                  | Robert Wolf (TDI) & Brenna Vredevelde (TDI) |
| 8:15-11:30  | Group 2: Riparian Woodland (break as needed)                   | Bill Wild (SPAWAR) & Anna Kellogg (TDI)     |

DAY 2 OBJECTIVES FOR GROUPS INCLUDE:

1. Identify strategic actions by building on the work of the previous day
2. Complete Table 2: Identification of Strategic Actions
3. Review and reassess management objectives
4. List research and monitoring needs
5. Evaluate level of urgency/priority and identify opportunities for implementation

**LUNCH: 11:30—12:30** (12:15-12:30 Facilitators meet with Carolyn Enquist)

**DAY 2 AFTERNOON SESSION 1:** Groups 1 & 2 Reassemble for Review and Synthesis

| Time        | Topic  | Presenters/Facilitator        |
|-------------|--|-------------------------------|
| 12:30-13:00 | Group 1: Coastal Sage Scrub presents/ reviews their priority strategic actions.  | Group 1/Carolyn Enquist (NPN) |
| 13:00-13:30 | Group 2: Riparian Woodland presents/ reviews their priority strategic actions.   | Group 2/Carolyn Enquist (NPN) |
| 13:30-14:15 | Opportunities for Strategic Action Implementation: Evaluate top priority actions considering barriers and key uncertainties. | Carolyn Enquist (NPN)         |

OUTCOMES OF REVIEW AND SYNTHESIS:

1. Identification of barriers to implementing strategic actions
2. Proposed opportunities for overcoming barriers to implement the actions
3. Evaluation of installation vs. regional level action

**BREAK: 14:15—14:30**

**DAY 2 AFTERNOON SESSION 2:** Next Steps and Wrap-Up

| Time        | Topic   | Presenters/Facilitator           |
|-------------|---|----------------------------------|
| 14:30-15:40 | Moving forward towards strategic climate informed monitoring: how do we set the stage to do this. | Carolyn Enquist (NPN)            |
| 15:40-15:50 | Workshop Summary, Outcomes and Next Steps: Dawn Lawson  | Dawn Lawson (SPAWAR SSC Pacific) |
| 15:50-16:00 | Closing Remarks: Christy Wolf   | Christy Wolf (Det. Fallbrook)    |

OUTCOMES FOR NEXT STEPS AND WRAP-UP:

1. The two groups share research and monitoring opportunities and needs identified in the breakout sessions.
2. Participants identify modifications to ongoing research and monitoring that would improve their ability to identify effects and respond to climate change.
3. Shared vision for practical climate-informed monitoring.

Page Intentionally Blank

# APPENDIX B

---



## List of Materials in Participant Binders

Page Intentionally Blank



## **Participant Binder Contents and Order**

### **Introduction –**

- Agenda
- List of Participants
- List of Workshop Definitions Relevant to Climate Change
- Rationale for Detachment Fallbrook as a Case Study

### **Powerpoint Slides -**

- Introduction (Dawn Lawson)
- San Diego County Future Climate Projections (Dan Cayan)
- How INRMPS work and Detachment FB RN program (Christy Wolf and Liz Kellogg)
- Present and Future Climate (Dan Cayan)
- Ecological impacts from climate change (Elsa Cleland)
- Adaptation Planning (Carolyn Enquist)
- Implementing Adapation Planning at Detachment Fallbrook (Robert Wolf)

### **General Working Group Materials -**

- SW Ecoregion MAP
- Future climate scenarios (from Cayan et al 2008).
- Historic Land Use MAP
- List of all management actions used on the installation
- List of all monitoring efforts undertaken on the installation

### **Working Group 1 CSS Materials -**

- Map of Coastal Sage Scrub on Detachment Fallbrook
- Description of Coastal Sage Scrub Ecosystem and Management Objectives on Detachment Fallbrook
- Management objectives for CSS from Detachment Fallbrook INRMP
- Table 1: climate change effects and relevant monitoring to be filled out on day 1.
- Table 2: management and monitoring strategies to be filled out on day 2.
- Draft conceptual model of system (wire diagram) as separate handouts.

### **Working Group 2: RIPARIAN Materials -**

- Map of Riparian habitats on Detachment Fallbrook
- Description of Riparian Ecosystem and Management Objectives on Detachment Fallbrook
- Management objectives for RIPARIAN from Detachment Fallbrook INRMP



## **Participant Binder Contents and Order**

- Table 1: climate change effects and relevant monitoring to be filled out on day 1.
- Table 2: management and monitoring strategies to be filled out on day 2.
- Draft conceptual model of system (wire diagram) as separate handouts.

### **Reference Materials -**

- Cayan DR, Maurer EP, Dettinger MD, Tyree M, Hayhoe K (2008) Climate change scenarios for the California region. *Climatic Change*, 87, S21–S42.
- Cross MS, McCarthy PD, Garfin G, Gori D, and C. Enquist. 2012. Accelerating adaptation of natural resource management to address climate change. *Conservation Biology*
- Cross MS, Zavaleta ES, Bachelet D et al 2012. The adaptation for conservation targets (ACT) Framework: a tool for incorporating climate change into natural resource management. *Environmental Management* 50:341-351
- Tingley MW, Estes LD and DS Wilcove. 2013. Climate change must not blow conservation off course. *Nature* 271-272.
- Various Others

# APPENDIX C

---

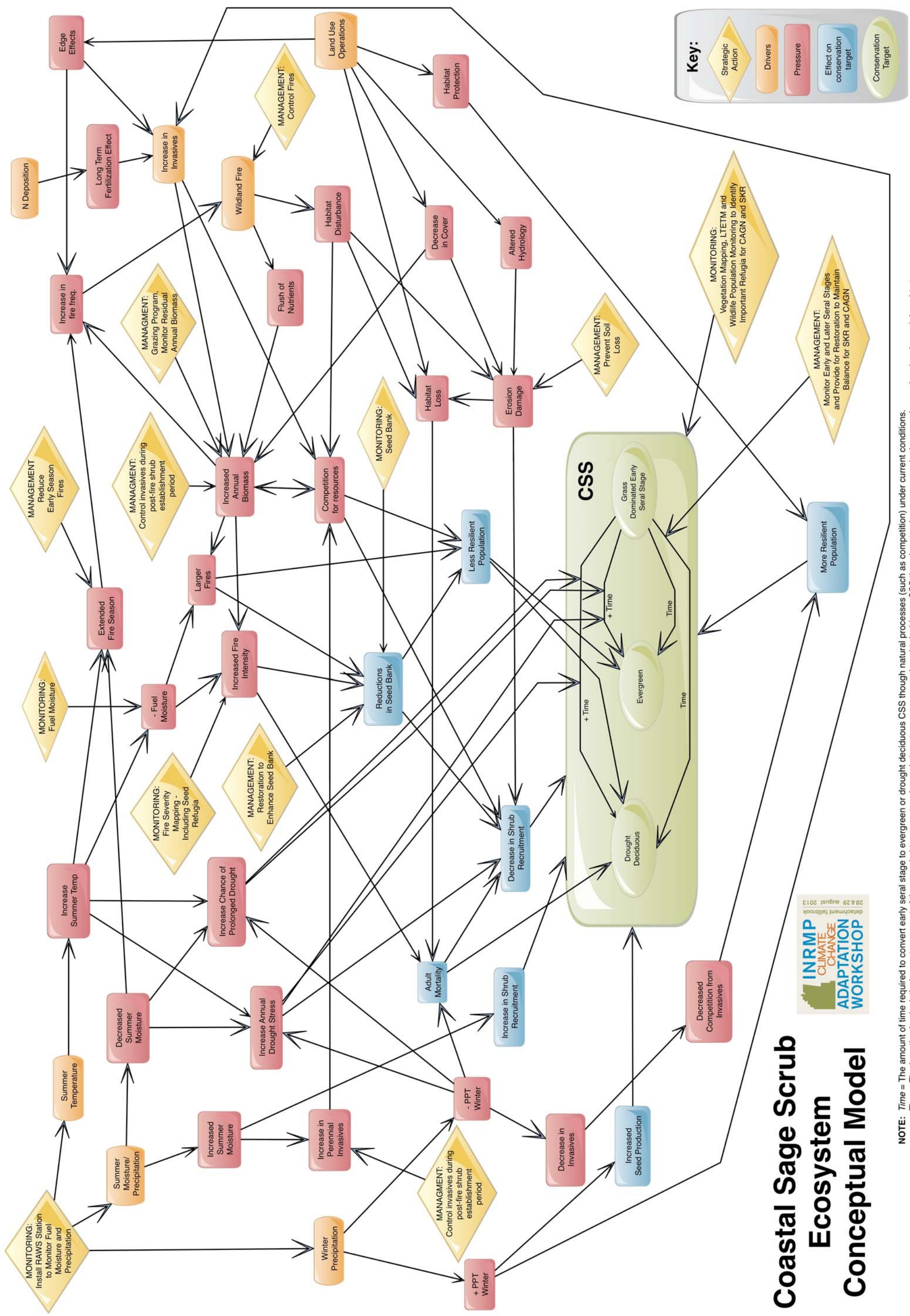


## -Group 1 Products-

### Coastal Sage Scrub

- Ecosystem Conceptual Model
- Hypotheses of Change Table
- Strategic Actions Table

Page Intentionally Blank



# Coastal Sage Scrub Ecosystem Conceptual Model



**NOTE:** *Time* = The amount of time required to convert early seral stage to evergreen or drought deciduous CSS though natural processes (such as competition) under current conditions.  
*+ Time* = The hypothesized relatively greater amount of time needed to convert early seral stage to evergreen or drought deciduous CSS though natural processes under increased annual and prolonged drought stress.

Page Intentionally Blank

**Table 1. Climate Change Effects (Hypotheses of Change)**  
Fallbrook INRMP Climate Change Adaptation Workshop  
*Group 1: Coastal Sage Scrub*

| Key Drivers<br>Influenced by Climate   | Projected<br>Climate Change Effect on Key Driver <sup>1</sup><br>Period: 2035-2064 | Likelihood <sup>2</sup> /Severity <sup>3</sup><br>of Climate Change Effect           |                                   | Hypothesis of Ecological<br>Change  |
|--|--|--|-----------------------------------|---|
|  |  | Scenario #1:<br>Moderate Change  | Scenario #2:<br>Extreme Change    |   |
| N Deposition<br>(made more accessible by<br>increased moisture)<br>Note – not CC-influenced, from air<br>pollution | Increased annual invasives.  | Very Likely<br>Severity is<br>Medium/High<br>(greater effect if<br>moisture is high) | Very Likely<br>Severity is Medium | <ul style="list-style-type: none"> <li>Increased biomass of annual exotics, therefore increase in fine fuel loads.</li> <li>Decreased shrub seedling establishment (from competition with exotic annuals)</li> </ul>  |
| Winter Precipitation   | Increase in winter precipitation.  | Likely/Low   | Likely/Low                        | <ul style="list-style-type: none"> <li>Results in increase in seed production</li> </ul>  |
| Wildfire   | Increased fire frequency   | Uncertain/High   | Uncertain/High                    | <ul style="list-style-type: none"> <li>Reduced shrub canopy cover</li> <li>Type conversion from CSS to annual grassland</li> <li>Dominance of deep-rooted shrubs (2 <i>evergreen species</i>) does better than 1 (<i>drought deciduous species</i>).</li> </ul> |
| Wildfire   | Extended fire season   | Uncertain/High   | Uncertain/High                    | <ul style="list-style-type: none"> <li>Early extension increases shrub mortality due to greater heat damage (because plants physiologically active unlike later in the season when they reduce physio. activity due to drought)</li> </ul>                      |

<sup>1</sup> Indicate Scenario (see description in heading) the effect applies to: “S1” = Scenario #1 only, “S2” = Scenario #2 only, or “S1+S2” = both.

<sup>2</sup> Likelihood of Effect: Very Likely, Likely, and Uncertain.

<sup>3</sup> Severity of Effect: High, Medium, Low (estimates based on expert knowledge).

**Table 1. Climate Change Impacts (Hypotheses of Change)**  
**Group 1: Coastal Sage Scrub (Continued)**

| Key Drivers Influenced by Climate | Projected Climate Change Effect on Key Driver <sup>1</sup><br>Period: 2035-2064 | Likelihood <sup>2</sup> /Severity <sup>3</sup><br>of Climate Change Effect |                                | Hypothesis of Ecological Change  |
|-----------------------------------|---|--|--------------------------------|--|
|                                   |   | Scenario #1:<br>Moderate Change  | Scenario #2:<br>Extreme Change |  |
| Wildfire                          | Increased intensity   | Uncertain/High   | Uncertain/High                 | <ul style="list-style-type: none"> <li>Greater mortality of adult shrubs – more pronounced effect on 1 (<i>drought deciduous species</i>) than 2 (<i>evergreen species</i>).</li> <li>Depleting seed bank – kill more seeds.</li> <li>Changes in soil chemistry due to higher heat.</li> </ul> |
| Wildfire                          | Larger Fires  | Uncertain/High   | Uncertain/High                 | <ul style="list-style-type: none"> <li>Loss of potential refugia for target species; and loss of sources for reseedling.</li> <li>More intensive use of remaining refugia.</li> <li>Homogenization of CSS subtypes.</li> </ul>   |
| Invasion**                        | Increase in winter precipitation leading to increase in annual biomass.         | Likely/Low   | Likely/Low                     | <ul style="list-style-type: none"> <li>Increase in annual biomass of exotic annuals reduces recruitment of both drought deciduous and deep rooted <i>shrub</i> species</li> </ul>  |
| Summer Moisture                   | Increase summer moisture  | Very Likely/Medium   | Unlikely/n/a                   | <ul style="list-style-type: none"> <li>Alter competition b/t 1 (<i>drought deciduous species</i>) and 2 (<i>evergreen species</i>). 2 would utilize moisture more/better. Allows growth.</li> <li>Seedling survival increase. Avoids <i>drought</i></li> </ul>                                 |

**Table 1. Climate Change Impacts (Hypotheses of Change)  
Group 1: Coastal Sage Scrub (Continued)**

| Key Drivers<br>Influenced by Climate  | Projected<br>Climate Change Effect on Key Driver <sup>1</sup><br>Period: 2035-2064 | Likelihood <sup>2</sup> /Severity <sup>3</sup><br>of Climate Change Effect |                                | Hypothesis of Ecological<br>Change  |
|---|--|--|--------------------------------|---|
|   |  | Scenario #1:<br>Moderate Change  | Scenario #2:<br>Extreme Change |   |
|   |  |  |                                | <i>induced</i> death.   |
| Summer Moisture   | Decrease summer moisture   | Unlikely/na  | Very Likely/Medium             | <ul style="list-style-type: none"> <li>Decreased seedling survival.</li> </ul>  |
| Summer Temperature  | Increase in temp leads to decreased fuel moisture.                                 | Likely/Low   | Likely /Medium                 | <ul style="list-style-type: none"> <li>Leads to increased fire – severity</li> <li>Decreased seedling survival.</li> </ul>  |
| Winter Precipitation (as a proxy for annual precipitation)  | Prolonged drought.   | Uncertain-Unlikely/na (based on uncertainty of the precipitation model)    | Uncertain Likely/Low-Medium    | <ul style="list-style-type: none"> <li>Increased adult <i>shrub</i> mortality.</li> <li>Decreased seed production.</li> <li>Decreased seedling establishment.</li> <li>.</li> </ul> |
| Important note from CSS day one discussion (re: example from Baja California where CAGN occupy habitat with different shrub species composition ) |  |  |                                | <ul style="list-style-type: none"> <li>Change in shrub species composition without loss of CAGN suitability.</li> </ul>   |
|   |  |  |                                |   |
|   |  |  |                                |   |

**Table 2. Identification of Strategic Actions to Address Climate Change Impacts for Scenarios #1 and #2**  
Fallbrook INRMP Climate Change Adaptation Workshop  
*Group 1: Coastal Sage Scrub*

**Management Objective:**

Maintain a healthy and heterogeneous CSS community that contains a balance of between early seral stage CSS (grass and forb dominated) suitable for Stephen's kangaroo rat and later seral stages suitable for the California gnatcatcher.

| Hypothesis of Ecological Climate Change Effect   | How Do We Detect? (Monitoring)  | Management Approach                                | Scenario #1 Strategic/Tactical Action              | Scenario #2 Strategic/Tactical Action              | Level of Urgency/Priority                          | Opportunities to Implement                         | Comments  |
|--|---|--|--|--|--|--|---|
| <ul style="list-style-type: none"> <li>Increased biomass of annual exotics, therefore increase in fine fuel loads. (N Deposition)</li> </ul> | <ul style="list-style-type: none"> <li>Didn't have time to address</li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <p>Related hypothesis of change that was addressed - Increase in annual biomass of exotic annuals reduces recruitment of both drought deciduous and evergreen species (Invasion – increase in winter PPT leads to increase in annual biomass)</p> |

**Table 2. Identification of Strategic Actions to Address Climate Change Impacts for Scenarios #1 and #2  
Group 1: Coastal Sage Scrub (*Continued*)**

**Management Objective:** Maintain a healthy and heterogeneous CSS community that contains a balance of between early seral stage CSS (grass and forb dominated) suitable for Stephen's kangaroo rat and later seral stages suitable for the California gnatcatcher.

| Hypothesis of Ecological Climate Change Effect  | How Do We Detect? (Monitoring)  | Management Approach                                | Scenario #1 Strategic/Tactical Action              | Scenario #2 Strategic/Tactical Action              | Level of Urgency/Priority                          | Opportunities to Implement                         | Comments  |
|---|---|--|--|--|--|--|---|
| <ul style="list-style-type: none"> <li>Decreased shrub seedling establishment (N Deposition)</li> </ul>                     | <ul style="list-style-type: none"> <li>Didn't have time to address</li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | Related hypothesis of change that were addressed – reduced seedling establishment due to reduced summer moisture and prolonged drought  |
| <ul style="list-style-type: none"> <li>Results in increase in seed production (Increase in winter precipitation)</li> </ul> | <ul style="list-style-type: none"> <li>Didn't have time to address</li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | Did not address a related hypothesis of change  |
| <ul style="list-style-type: none"> <li>Reduced shrub canopy cover (increased fire frequency)</li> </ul>                     | <ul style="list-style-type: none"> <li>Didn't have time to address</li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | Related hypotheses of change that were addressed included shrub mortality due to more fire, extended fire and competition with annuals. |

**Table 2. Identification of Strategic Actions to Address Climate Change Impacts for Scenarios #1 and #2  
Group 1: Coastal Sage Scrub (*Continued*)**

**Management Objective:** Maintain a healthy and heterogeneous CSS community that contains a balance of between early seral stage CSS (grass and forb dominated) suitable for Stephen's kangaroo rat and later seral stages suitable for the California gnatcatcher.

| Hypothesis of Ecological Climate Change Effect   | How Do We Detect? (Monitoring)  | Management Approach                                | Scenario #1 Strategic/Tactical Action              | Scenario #2 Strategic/Tactical Action              | Level of Urgency/Priority                          | Opportunities to Implement                         | Comments  |
|--|---|--|--|--|--|--|---|
| <ul style="list-style-type: none"> <li>Type conversion from CSS to annual grassland (increased fire frequency)</li> </ul>            | <ul style="list-style-type: none"> <li>Didn't have time to address</li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | Related hypotheses of change that were addressed included shrub mortality due to more fire.   |
| <ul style="list-style-type: none"> <li>Dominance of deep-rooted shrubs (2 does better than 1). (Increased fire frequency)</li> </ul> | <ul style="list-style-type: none"> <li>Didn't have time to address</li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | <ul style="list-style-type: none"> <li></li> </ul> | Related hypothesis of change that was addressed - Greater mortality of adult shrubs from fire – more pronounced effect on 1 ( <i>drought deciduous species</i> ) than 2 ( <i>evergreen species</i> ). |

**Table 2. Identification of Strategic Actions to Address Climate Change Impacts for Scenarios #1 and #2  
Group 1: Coastal Sage Scrub (Continued)**

**Management Objective:** Maintain a healthy and heterogeneous CSS community that contains a balance of between early seral stage CSS (grass and forb dominated) suitable for Stephen's kangaroo rat and later seral stages suitable for the California gnatcatcher.

| Hypothesis of Ecological Climate Change Effect   | How Do We Detect? (Monitoring)   | Management Approach  | Scenario #1 Strategic/Tactical Action   | Scenario #2 Strategic/Tactical Action   | Level of Urgency/Priority   | Opportunities to Implement  | Comments   |
|--|--|--|---|---|---|---|--|
| <ul style="list-style-type: none"> <li>Early extension increases higher shrub mortality due to greater heat damage. (Extended Fire Season)</li> <li>Extension of fire season likely based on fuel moisture.</li> </ul> | <ul style="list-style-type: none"> <li>Monitor fuel moisture</li> <li>Remote Access Weather Station</li> </ul>   | <ul style="list-style-type: none"> <li>Reduce early season fires</li> </ul>  | <ul style="list-style-type: none"> <li>Pre-fire planning – possibly target habitats for priority protection</li> <li>Increase fire watch</li> </ul>         | <ul style="list-style-type: none"> <li>same</li> </ul>  | <ul style="list-style-type: none"> <li>Moderate – because ignitions sources on-base are low (<i>highly controlled to support mission</i>), but still threat of fire spread from off-installation</li> </ul> | <ul style="list-style-type: none"> <li>Pre-fire (via planning) – review of FMP</li> </ul>                           |  |
| <ul style="list-style-type: none"> <li>Greater mortality of adult shrubs from fire – more pronounced effect on 1 (<i>drought deciduous species</i>) than 2 (<i>evergreen species</i>).</li> </ul>                      | <ul style="list-style-type: none"> <li>Veg. mapping. – including % cover.</li> <li>Vegetation transects (LTETM) – may require modification of existing protocol.</li> <li>Determine ecological effect of hypothesized change (on SKR &amp; CAGN) &amp; base management on that ecological effect.</li> </ul> | <ul style="list-style-type: none"> <li>Control invasives during post-fire shrub establishment period</li> <li>Control fire.</li> </ul> | <ul style="list-style-type: none"> <li>Weed control to reduce moisture competition.</li> <li>Prioritize action sites based on T/E species needs.</li> </ul> | <ul style="list-style-type: none"> <li>Retain soil moisture.</li> <li>Weed control to reduce moisture competition.</li> </ul> | <ul style="list-style-type: none"> <li>High – meets multiple goals &amp; limited time frame for implementation (post-fire)</li> </ul>   | <ul style="list-style-type: none"> <li>Post-fire (0-3 yrs)</li> <li>Under current installation authority</li> </ul> | <p>Monitoring program may be too expensive. LTETM plots currently resampled irregularly.</p> <p>Goal: balance CSS stages, so some loss of shrub cover to revert to SKR suitable habitat would be acceptable (<i>at this time but may not be in the future if shrub die off is substantial</i>)</p> |

**Table 2. Identification of Strategic Actions to Address Climate Change Impacts for Scenarios #1 and #2  
Group 1: Coastal Sage Scrub (Continued)**

**Management Objective:** Maintain a healthy and heterogeneous CSS community that contains a balance of between early seral stage CSS (grass and forb dominated) suitable for Stephen's kangaroo rat and later seral stages suitable for the California gnatcatcher.

| Hypothesis of Ecological Climate Change Effect  | How Do We Detect? (Monitoring)  | Management Approach   | Scenario #1 Strategic/Tactical Action  | Scenario #2 Strategic/Tactical Action  | Level of Urgency/Priority   | Opportunities to Implement   | Comments   |
|---|---|---|--|--|---|--|--|
| <ul style="list-style-type: none"> <li>Depleting seed bank – kill more seeds. (increased fire intensity)</li> </ul>   | Monitor plant community or seed bank. Stratified sampling w/ representative plots. (potential modification of LTETM). Determine/monitor fire intensity (seed refugia) as part of post-fire mapping. | Re-establish species in community to naturally replenish seed bank.   | <ul style="list-style-type: none"> <li>Maintain seed collection.</li> <li>Sparse planting or seeding.</li> </ul>                                 | <ul style="list-style-type: none"> <li>Maintain seed collection.</li> <li>Sparse planting or seeding.</li> </ul>                                 | <ul style="list-style-type: none"> <li>High for maintaining seed bank.<sup>4</sup></li> <li>Sparse planting or seeding depends on post-fire situation.</li> </ul> | Pre and post-fire. Seed collection year-round pre-fire.                        | Fire severity on each climate scenario difficult to predict, so strategic actions <i>were</i> similar. |
| <ul style="list-style-type: none"> <li>Changes in soil chemistry due to higher heat. (increased fire intensity)</li> </ul>                                  | Fire severity mapping.  | Determine ecological effect, evaluate effect with respect to management objectives (SKR & CAGN); determine if action is warranted. Prevent soil loss. | <ul style="list-style-type: none"> <li>Seeding and erosion control.</li> <li>Control fire intensity. – grazing, prescribed fire, etc.</li> </ul> | <ul style="list-style-type: none"> <li>Seeding and erosion control.</li> <li>Control fire intensity. – grazing, prescribed fire, etc.</li> </ul> | Low-Moderate  | Post-fire.   | Management techniques might be too involved for impact that might not be that significant.             |
| <ul style="list-style-type: none"> <li>Loss of potential refugia for target wildlife species; and loss of sources for reseedling. (Larger fires)</li> </ul> | Veg. mapping. Wildlife population monitoring. Identify important refugia.   | Identify & protect important populations & refugia from fire.   | <ul style="list-style-type: none"> <li>Pre-fire planning.</li> <li>Fire breaks.</li> <li>Possible air support.</li> </ul>                        | Same   | Planning is High.   | Pre-fire. Write into FMP. During fire – implement strategies written into FMP. | All fire actions should be written into Fire Plan.   |

<sup>4</sup> Not sure I (DL) agree this is high. Perhaps the effect is too simplified ie it is unlikely that the seedbank will be depleted without a change in suitability of the habitat for the species so I am not sure that restocking the seedbank will be effective.

**Table 2. Identification of Strategic Actions to Address Climate Change Impacts for Scenarios #1 and #2  
Group 1: Coastal Sage Scrub (*Continued*)**

**Management Objective:** Maintain a healthy and heterogeneous CSS community that contains a balance of between early seral stage CSS (grass and forb dominated) suitable for Stephen's kangaroo rat and later seral stages suitable for the California gnatcatcher.

| Hypothesis of Ecological Climate Change Effect   | How Do We Detect? (Monitoring)  | Management Approach  | Scenario #1 Strategic/Tactical Action   | Scenario #2 Strategic/Tactical Action | Level of Urgency/Priority | Opportunities to Implement   | Comments  |
|--|---|--|---|---------------------------------------|---------------------------|--|---|
| <ul style="list-style-type: none"> <li>More intensive use of remaining refugia (Larger fires)</li> </ul> | Skip – too esoteric   |  |   |                                       |                           |  |   |
| <ul style="list-style-type: none"> <li>Homogenization of CSS subtypes. (Larger fires)</li> </ul>         | Veg. mapping.<br>Also LTETM.<br>Fire mapping (for extent and intensity) | <ul style="list-style-type: none"> <li>Limit fire size.</li> <li>Based on effects, strategic post-fire restoration to increase recruitment and diversity.</li> </ul> | <ul style="list-style-type: none"> <li>Increase suppression.</li> <li>Strategic plant community restoration.</li> </ul> | Same                                  | Low                       | Post-fire.<br>(Uncertain how it will play out – monitoring to determine what is actually happening even more important). | Assumption that fire prevention is a strategy for all fire-related drivers. |

**Table 2. Identification of Strategic Actions to Address Climate Change Impacts for Scenarios #1 and #2  
Group 1: Coastal Sage Scrub (Continued)**

**Management Objective:** Maintain a healthy and heterogeneous CSS community that contains a balance of between early seral stage CSS (grass and forb dominated) suitable for Stephen's kangaroo rat and later seral stages suitable for the California gnatcatcher.

| Hypothesis of Ecological Climate Change Effect   | How Do We Detect? (Monitoring)   | Management Approach  | Scenario #1 Strategic/Tactical Action  | Scenario #2 Strategic/Tactical Action | Level of Urgency/Priority               | Opportunities to Implement  | Comments   |
|--|--|--|--|---------------------------------------|---|---|--|
| <ul style="list-style-type: none"> <li>Increase in annual biomass of exotic annuals reduces recruitment of both drought deciduous and evergreen species (invasion – increase in winter PPT leads to increase in annual biomass)</li> </ul> | <ul style="list-style-type: none"> <li>Residual dry matter monitoring for grazing program.</li> <li>Shrub recruitment detection could be some version of LTETM.</li> <li>Precipitation/ weather monitoring.</li> </ul> | <ul style="list-style-type: none"> <li>Reduce annual biomass or enhancing shrubs.</li> </ul> | <ul style="list-style-type: none"> <li>Increase use of &amp; potentially alter timing of grazing.</li> <li>Identify and monitor new invasives (emerging threats) – (a) those that are here, but not invasive now &amp; (b) not here yet.</li> <li>Stay informed of new invasive threats via regional weed networks.</li> </ul> | Same                                  | High                                    | <ul style="list-style-type: none"> <li>Align with rare plant surveys every 5 years.</li> <li>Annual review of new invasive threat info.</li> <li>Annual grazing monitoring.</li> <li>Monitoring shrub recruitment dynamics – tied to precipitation monitoring.</li> </ul> | Weather monitoring a common thread through all climate-influenced drivers.                                     |
| <ul style="list-style-type: none"> <li>Alter competition between 1 (<i>drought deciduous species</i>) and 2(<i>evergreen species</i>) . 2 would utilize moisture more/better. Allows growth. (increased summer moisture)</li> </ul>        | <ul style="list-style-type: none"> <li>Veg. mapping.</li> <li>LTETM – w/ some modification.</li> </ul>   | Evaluate effect of change on target (CAGN). Maintain structure suitable for CAGN.            | Control ( <i>evergreen species</i> ) <i>Malosma/Rhus</i> .   | No action.                            | Low (due to amount of CSS present now). | Ongoing.  | Likelihood of implementation is low – ecological hypothesis assumes relatively good quality CSS to begin with. |

**Table 2. Identification of Strategic Actions to Address Climate Change Impacts for Scenarios #1 and #2  
Group 1: Coastal Sage Scrub (*Continued*)**

**Management Objective:** Maintain a healthy and heterogeneous CSS community that contains a balance of between early seral stage CSS (grass and forb dominated) suitable for Stephen's kangaroo rat and later seral stages suitable for the California gnatcatcher.

| Hypothesis of Ecological Climate Change Effect  | How Do We Detect? (Monitoring)  | Management Approach   | Scenario #1 Strategic/Tactical Action                       | Scenario #2 Strategic/Tactical Action | Level of Urgency/Priority           | Opportunities to Implement | Comments  |
|---|---|---|---|---------------------------------------|-------------------------------------|----------------------------|---|
| <ul style="list-style-type: none"> <li>Seedling survival increase. Avoids drought induced death. (increased summer moisture)</li> </ul> | <ul style="list-style-type: none"> <li>LTETM – w/ some modification</li> <li>Weather monitoring.</li> </ul> | Determine effect on SKR habitat. If an effect, take strategic action; if no effect, do nothing. | Grazing – to reduce shrub seedling survival in SKR habitat. | No action.                            | Medium for maintaining SKR habitat. |                            | Review consistency of management approaches and actions relative to management objective (to maintain balance between SKR and CAGN habitat) |

**Table 2. Identification of Strategic Actions to Address Climate Change Impacts for Scenarios #1 and #2  
Group 1: Coastal Sage Scrub (Continued)**

| Management Objective: Maintain a healthy and heterogeneous CSS community that contains a balance of between early seral stage CSS (grass and forb dominated) suitable for Stephen's kangaroo rat and later seral stages suitable for the California gnatcatcher. |                                      |   |                                       |  |                           |  |  |
|--|--------------------------------------|---|---------------------------------------|--|---------------------------|--|--|
| Hypothesis of Ecological Climate Change Effect   | How Do We Detect? (Monitoring)       | Management Approach   | Scenario #1 Strategic/Tactical Action | Scenario #2 Strategic/Tactical Action  | Level of Urgency/Priority | Opportunities to Implement                                 | Comments   |
| <ul style="list-style-type: none"><li>Decreased seedling survival. (decreased summer moisture from precipitation and fog)</li><li>Clarification – seedling establishment and survival in the absence of fire.</li></ul>  | Weather station and LTETM monitoring | Determine where it is happening (in SKR or CAGN target habitats) and thus management implication. | N/a                                   | <ul style="list-style-type: none"><li>No action – if (a) within target SKR habitat (based on ecological and land use considerations ) or, (b) within target CAGN habitat and not below suitability threshold, (c) if not resisting CC effect</li><li>Supplemental water for naturally established seedlings in summer in target CAGN habitats.</li></ul> | Low-Moderate/             | Triggered by consecutive years of reduced summer moisture. | Mgmt approach will depend on balance (current and desired) re: SKR and CAGN habitat. Management actions to prepare for changes, but evaluate relative to objectives. |
| <ul style="list-style-type: none"><li>Leads to increased fire – severity (increase in summer temp leads to decreased fuel moisture)</li></ul>  |                                      |   |                                       |  |                           |  | Review management actions – identify as pre-emptive, or reactive.  |

**Table 2. Identification of Strategic Actions to Address Climate Change Impacts for Scenarios #1 and #2**  
**Group 1: Coastal Sage Scrub (*Continued*)**

**Management Objective:** Maintain a healthy and heterogeneous CSS community that contains a balance of between early seral stage CSS (grass and forb dominated) suitable for Stephen's kangaroo rat and later seral stages suitable for the California gnatcatcher.

| Hypothesis of Ecological Climate Change Effect   | How Do We Detect? (Monitoring) | Management Approach  | Scenario #1 Strategic/Tactical Action   | Scenario #2 Strategic/Tactical Action | Level of Urgency/Priority   | Opportunities to Implement | Comments   |
|--|--------------------------------|--|---|---------------------------------------|---|----------------------------|--|
| <ul style="list-style-type: none"> <li>Decreased seedling survival. (increase in summer temp leads to decreased fuel moisture)</li> </ul>  | repeat                         |  |   |                                       |   |                            |  |
| <ul style="list-style-type: none"> <li>Increased adult shrub mortality. (Prolonged drought)</li> <li>Hypothesis – more mortality in drought deciduous CSS species.</li> <li>Prolonged drought will result in a decrease in abundance of annual invasives.</li> </ul> | Weather monitoring. LTETM      | <ul style="list-style-type: none"> <li>Control invasives from gaining ground in shrub mortality areas.</li> <li>If effect is widespread, decision to be made – restore back to CSS or convert to SKR habitat?</li> </ul> | <ul style="list-style-type: none"> <li>Spray perennial invasives as preventative measure.</li> <li>Strategic plantings of shrubs.</li> <li>Modify annual grazing targets to reflect annual biomass level and distribution.</li> </ul> | Same                                  | <ul style="list-style-type: none"> <li>Modifications to grazing – High</li> <li>Spraying perennial invasives</li> </ul> |                            | Note – may be important to review/evaluate LTETM program in context of climate change. |
| <ul style="list-style-type: none"> <li>Decreased seed production. (Prolonged drought)</li> </ul>   |                                |  |   |                                       |   |                            |  |
| <ul style="list-style-type: none"> <li>Decreased seedling establishment. (Prolonged drought)</li> </ul>  |                                |  |   |                                       |   |                            |  |

**Table 2. Identification of Strategic Actions to Address Climate Change Impacts for Scenarios #1 and #2  
Group 1: Coastal Sage Scrub (Continued)**

**Management Objective:** Maintain a healthy and heterogeneous CSS community that contains a balance of between early seral stage CSS (grass and forb dominated) suitable for Stephen's kangaroo rat and later seral stages suitable for the California gnatcatcher.

| Hypothesis of Ecological Climate Change Effect  | How Do We Detect? (Monitoring)   | Management Approach   | Scenario #1 Strategic/Tactical Action  | Scenario #2 Strategic/Tactical Action  | Level of Urgency/Priority | Opportunities to Implement | Comments   |
|---|--|---|--|--|---------------------------|----------------------------|--|
| <ul style="list-style-type: none"> <li>Change in shrub species composition without loss of CAGN suitability.</li> </ul>                       |  |   |  |  |                           |                            |  |
| <ul style="list-style-type: none"> <li>Greater mortality of adult shrubs from extended drought—more pronounced effect on 1 than 2.</li> </ul> | <ul style="list-style-type: none"> <li>Vegetation transects (LTETM) – may require modification of existing protocol.</li> <li>Determine ecological effect of hypothesized change (on SKR &amp; CAGN) &amp; base management on that ecological effect.</li> </ul> | <ul style="list-style-type: none"> <li>Revegetation – may not be feasible depending on the scale</li> <li>Address invasives that might be competing for water</li> <li>Do nothing – allow natural change</li> <li>Control fire.</li> <li>Prioritize CSS stands for action/ protection.</li> </ul> | <ul style="list-style-type: none"> <li>Grazing to reduce annual biomass.</li> <li><sup>5</sup>Weed control to reduce moisture competition.</li> <li>Prioritize action sites based on T/E species needs.</li> </ul> | <ul style="list-style-type: none"> <li>Weed control to reduce moisture competition.</li> </ul> |                           |                            | <p>Monitoring program may be too expensive. LTETM plots currently resampled irregularly.</p> <p>Goal: balance CSS stages, so some loss of shrub cover to revert to SKR suitable habitat would be acceptable (<i>at this time but may not be in the future if shrub die off is substantial</i>)</p> |

<sup>5</sup> Retaining soil moisture is not a strategic action and I believe that retaining soil moisture referred to weed control. (DL)

# APPENDIX D

---



## -Group 2 Products-

### Riparian Woodland

- Ecosystem Conceptual Model
- Hypotheses of Change Table
- Strategic Actions Table

Page Intentionally Blank



Page Intentionally Blank

**Table 1. Climate Change Effect (Hypotheses of Change)**  
Fallbrook INRMP Climate Change Adaptation Workshop  
*Group 2: Riparian Woodlands*

| Key Drivers<br>Influenced by Climate | Projected<br>Climate Change Effect on Key Driver <sup>1</sup><br>Period: 2035-2064 | Likelihood <sup>2</sup> /Severity <sup>3</sup><br>of Climate Change Effect |                                | Hypothesis of<br>Ecological Change  |
|--------------------------------------|--|--|--------------------------------|---|
|                                      |  | Scenario #1:<br>Moderate Change  | Scenario #2:<br>Extreme Change |   |
| Winter storm intensity               | Higher peak flows<br>Streambed/bank scour<br>Deposition of clayey sediment         | Likely/Medium  | Likely/Medium                  | Recruitment of sycamores and willows will improve due to scour and sediment deposition  |
| Summer Moisture and Temperature      | Extended summer drought with higher temperatures/evapotranspiration                | unlikely/low   | Very Likely/ High              | possible death of adult sycamores due to rate of groundwater decline.<br>Decline in long-term recruitment of young oaks, sycamores.<br>Eventual decline of willows. |

<sup>1</sup> Indicate Scenario (see description in heading) the Effect applies to: "S1" = Scenario #1 only, "S2" = Scenario #2 only, or "S1+S2" = both.

<sup>2</sup> Likelihood of Effect: Very Likely, Likely, Unlikely, and Uncertain.

<sup>3</sup> Severity of Effect: High, Medium, Low (estimates based on expert knowledge).

**Table 1. Climate Change Impacts (Hypotheses of Change)**  
**Group 2: Riparian Woodlands (Continued)**

| Key Drivers<br>Influenced by Climate                   | Projected<br>Climate Change Effect on Key Driver <sup>1</sup><br>Period: 2035-2064 | Likelihood <sup>2</sup> /Severity <sup>3</sup><br>of Climate Change Effect |                                | Hypothesis of<br>Ecological Change  |
|--|--|--|--------------------------------|---|
|  |  | Scenario #1:<br>Moderate Change  | Scenario #2:<br>Extreme Change |   |
| Large storms   | -Scouring (increased intensity, but not frequency)<br>-Erosion, sedimentation      | Likely/low negative effects, mostly positive effects                       | Uncertain/low                  | -Increased recruitment<br>-Temporary habitat loss   |
| Precipitation phenology                                | Erosion, sedimentation   | Likely/low   | Likely/low                     | -water availability for wildlife<br>-temporary habitat loss   |
| Decreased precipitation                                | Increased fire frequency<br>Increased flammability                                 | Likely/high  | Very likely/high               | -decreased water table<br>-decreased water quality  |
| Prolonged drought, decreased ground water availability | Increased fire frequency<br>Increased flammability<br>Change in water availability | Likely/high  | Very likely/high               | -tree mortality<br>-simplified structures<br>-wildlife mortality  |
| Habitat fragmentation                                  | Modified population dynamics<br>Invasion pressures                                 | Likely/moderate  | Very likely/high               | -species shifts<br>-wildlife mortality<br>-type conversion<br>-reduced recruitment<br>-decreased health<br>-decreased age structure |
| Pathogens, infestations                                | Modified population dynamics   | Likely/medium  | Very likely/high               | -species shifts<br>-wildlife mortality<br>-type conversion<br>-reduced recruitment<br>-decreased health<br>-decreased age structure |

**Table 1. Climate Change Impacts (Hypotheses of Change)**  
**Group 2: Riparian Woodlands (Continued)**

| Key Drivers<br>Influenced by Climate | Projected<br>Climate Change Effect on Key Driver <sup>1</sup><br>Period: 2035-2064                            | Likelihood <sup>2</sup> /Severity <sup>3</sup><br>of Climate Change Effect |                                | Hypothesis of<br>Ecological Change                         |
|--------------------------------------|---|--|--------------------------------|--|
|                                      |   | Scenario #1:<br>Moderate Change  | Scenario #2:<br>Extreme Change |  |
| Wildland fire                        | Decreased fire intervals<br>Altered intensity   | Likely/high  | Very likely/high               | -wildlife mortality<br>-fragmentation<br>-habitat loss     |
| Exotic invasion                      | Decreased habitat for recruitment<br>Competition for adults<br>Increased flammability<br>Resource competition | uncertain  | uncertain                      | -Population decline  |
| Increased temperature                | Increased stress on sycamores and willows<br>Modified population dynamics                                     | Very likely/high   | Very likely/high               | -Fragmentation<br>-decreased vigor<br>-increased mortality |
| Upstream pollution                   | Altered nutrient availability<br>Pesticides   | Uncertain  | Uncertain                      | -Shifting baselines  |
| Waterstream phenology                | Altered flows   | Likely/low   | Very likely/medium             | -Wildlife water<br>availability<br>-oak mortality          |
| Historic anthropogenic alterations   | Channelization<br>Lower water table<br>Collapsing banks   | Likely/medium  | Likely/low                     | -oak mortality   |

**Table 2. Identification of Strategic Actions to Address Climate Change Impacts for Scenarios #1 and #2**  
Fallbrook INRMP Climate Change Adaptation Workshop  
*Group 2: Riparian Woodlands*

**Management Objective:**

**Maintain suitable habitat and conditions for the least Bell's vireo.**

| Hypothesis of Ecological Climate Change Effect  | How Do We Detect? (Monitoring)   | Management Approach   | Scenario #1 Strategic Action   | Scenario #2 Strategic Action                                  | Level of Urgency/Priority | Opportunities to Implement | Comments |
|---|--|---|--|---|---------------------------|----------------------------|----------|
| Recruitment of sycamores and willows will improve due to scour and sediment deposition          | Stream profile or cross-section monitoring<br>Recruitment                  | Streamflow management promotes scour, sediment deposition, nutrient flush |  |   | Low                       |                            |          |
| Death of adult oak trees, possible death of adult sycamores due to rate of groundwater decline. | Depth of groundwater.<br>Canopy of oak, sycamore, willow.<br>Age structure | Control invasives that compete for groundwater                            | Control Arundo to protect higher water table.  | More aggressive or regional invasive species and fire control |                           |                            |          |
|   |  | Promote recruitment   | Active measures to protect herbivory of oak seedlings.<br>Water in summer/fall oak and sycamore seedlings, willow saplings | Add impoundments in upper watershed as refugia for willows    |                           |                            |          |
|   |  |   | Continue grazing with understory management to promote grasses   | Active fire control   |                           |                            |          |

**Table 2. Identification of Strategic Actions to Address Climate Change Impacts for Scenarios #1 and #2  
Group 2: Riparian Woodlands (Continued)**

| Management Objective:   |  | Maintain suitable habitat and conditions for the least Bell's vireo.  |  |  |   |  |
|---|--|---|--|--|---|--|
| Hypothesis of Ecological Climate Change Effect  | How Do We Detect? (Monitoring)   | Management Approach   | Scenario #1 Strategic Action   | Scenario #2 Strategic Action   | Level of Urgency/Priority                                       | Opportunities to Implement                                     |
| -species shifts<br>-wildlife mortality<br>-type conversion<br>-reduced recruitment<br>-decreased health<br>-decreased age structure | -habitat mapping (plant communities)<br>-food, shelter, water availability<br>-focused sampling on recruitment, age structure, & mortality<br>-enhance long term ecological trends effort<br>-monitor breeding season shifts<br>-tracking stations, cameras (bobcats)<br>-presence/absence of indicator species<br>-predator/prey bases and monitoring invertebrates | -standardize & more rigorous protocols (first reproduction date, timing of fledging)<br>-improve water availability<br>-invasive control & restoration<br>-expand long term monitoring program to include other metrics (e.g., invertebrates) | - use treated water<br>-restore natural channel morphology<br>-manage water flow (impoundments)<br>-conduct fluvial assessment to identify mitigation opportunities & assess stream community structure/geomorphology<br>-tie mitigation opportunity to infrastructure integrity<br>-Exotics control | - use treated water<br>-restore natural channel morphology<br>-manage water flow (impoundments)<br>-conduct fluvial assessment to identify mitigation opportunities & assess stream community structure/geomorphology<br>-tie mitigation opportunity to infrastructure integrity<br>-Exotics control | Stream assessment: moderate<br>All other strategic actions: low | -partnership for study design<br>Driver: habitat fragmentation |
|   |  |   |  |  |   |  |

**Table 2. Identification of Strategic Actions to Address Climate Change Impacts for Scenarios #1 and #2**  
**Group 2: Riparian Woodlands (Continued)**

**Management Objective:** Maintain suitable habitat and conditions for the least Bell's vireo.

| Hypothesis of Ecological Climate Change Effect   | How Do We Detect? (Monitoring)  | Management Approach   | Scenario #1 Strategic Action   | Scenario #2 Strategic Action   | Level of Urgency/Priority            | Opportunities to Implement                                 | Comments  |
|--|---|---|--|--|--------------------------------------|--|---|
| -wildlife mortality<br>-fragmentation<br>-habitat loss                                 | -habitat mapping<br>-enhance long term ecological trends effort   | -maintain low fuel load through strategic grazing management<br>-lengthen fire intervals        | -fencing<br>-shade structure<br>-water troughs<br>-controlled burns<br>-Exotics control                | -fencing<br>-shade structure<br>-water troughs<br>-controlled burns<br>-Exotics control                | -high                                | -part of INRMP<br>-prescribed burns difficult to implement | Driver: wildland fire   |
| -Fragmentation<br>-decreased vigor<br>-increased mortality                             | -habitat mapping<br>-focused sampling on plant vigor & mortality<br>-enhance long term ecological trends effort | -improve water availability<br>-slow down water<br>-link willow & sycamore death to heat stress | - use treated water<br>-restore natural channel morphology   | - use treated water<br>-restore natural channel morphology   |                                      | -funding/policy issue                                      | Driver: increased temperature   |
| Recruitment of sycamores and willows will improve due to scour and sediment deposition | Stream profile or cross-section monitoring<br>Recruitment   | Streamflow management promotes scour, sediment deposition, nutrient flush                       | -Stabilization<br>-Test water quality<br>- reused treated water<br>-restore natural channel morphology | -Stabilization<br>-test water quality<br>- reused treated water<br>-restore natural channel morphology | Low urgency, low funding feasibility | -20 year plan<br>-mitigation (policy permitting/ from CP)  | Funding issue<br>Additional benefits: sediment, water quality control & habitat |

# APPENDIX E

---



## Powerpoint Presentations

The contents of appendix E can be found in the following pdf files:

- 1) [DetFB\\_CCA\\_WorkshopSum\\_AppE\\_part\\_1\\_of\\_2.pdf](#)
- 2) [DetFB\\_CCA\\_WorkshopSum\\_AppE\\_part\\_2\\_of\\_2.pdf](#)

Page Intentionally Blank